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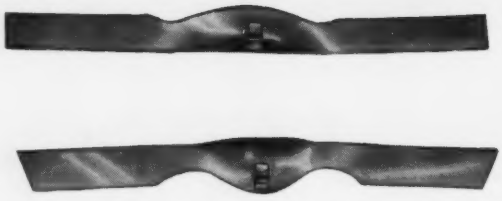

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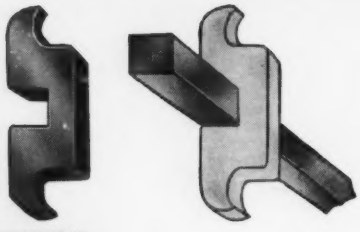

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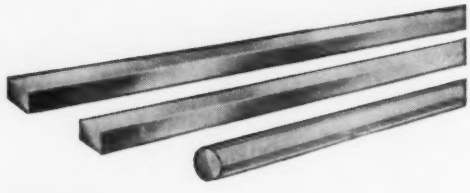

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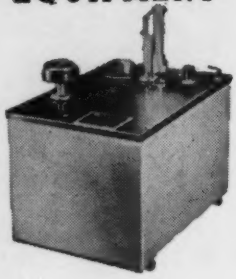

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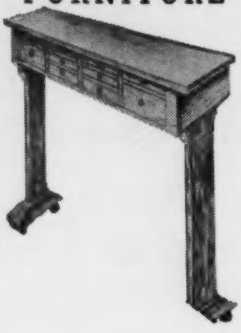

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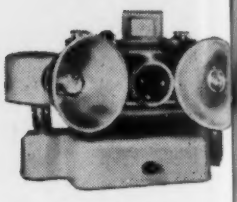

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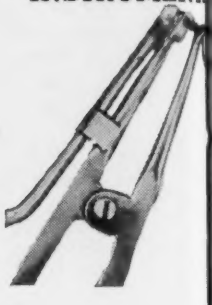

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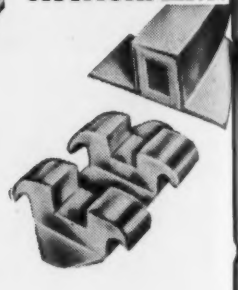

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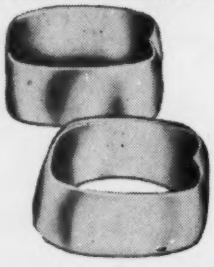

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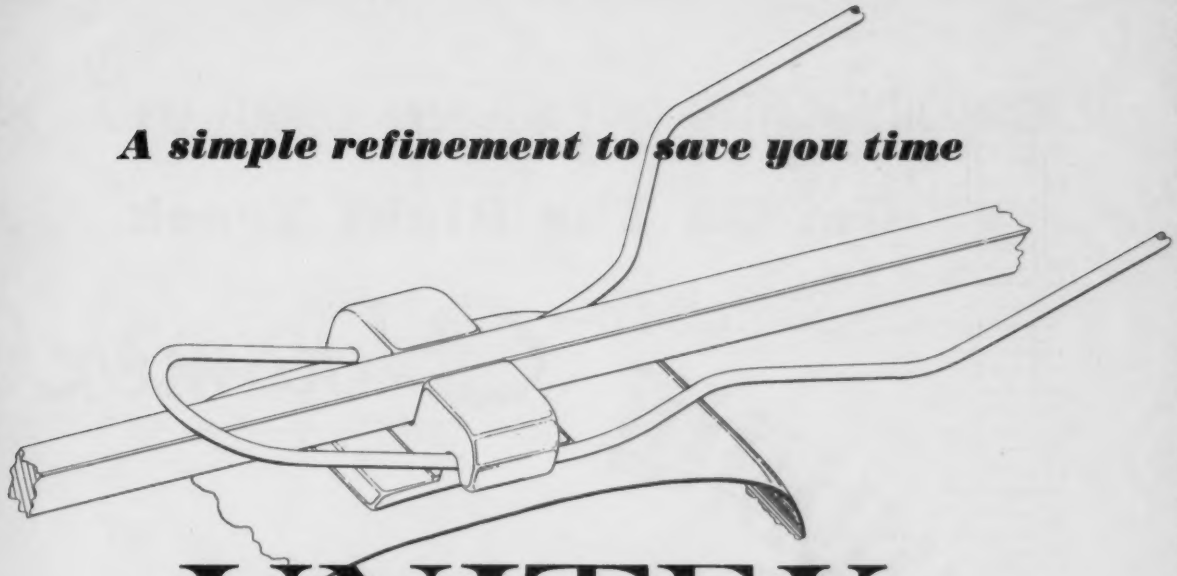

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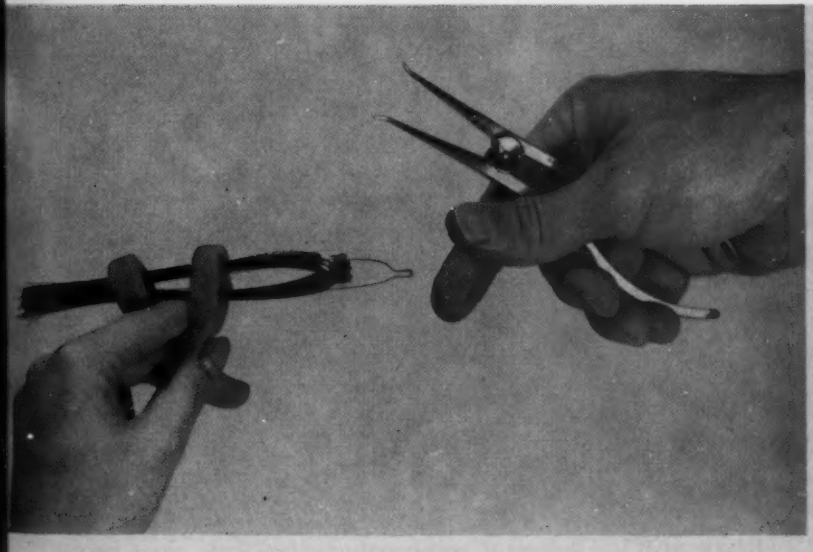

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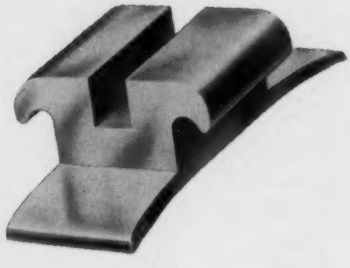

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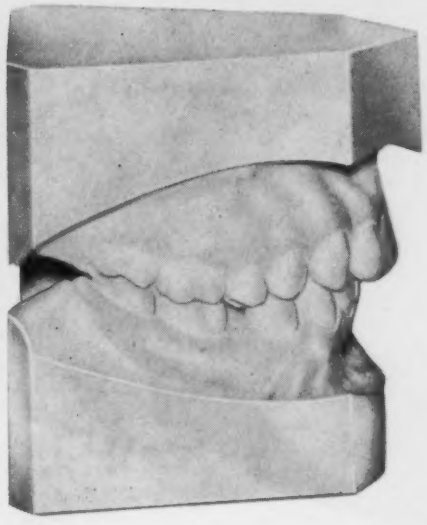

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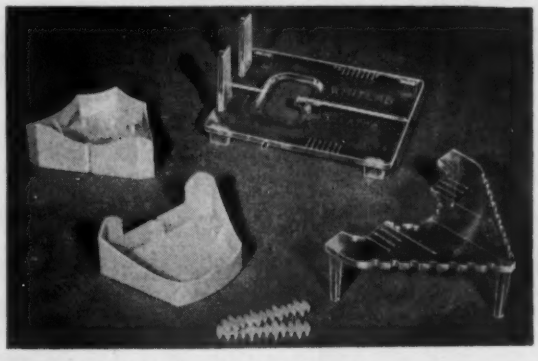

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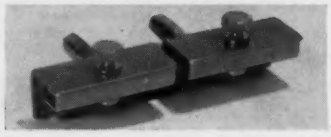

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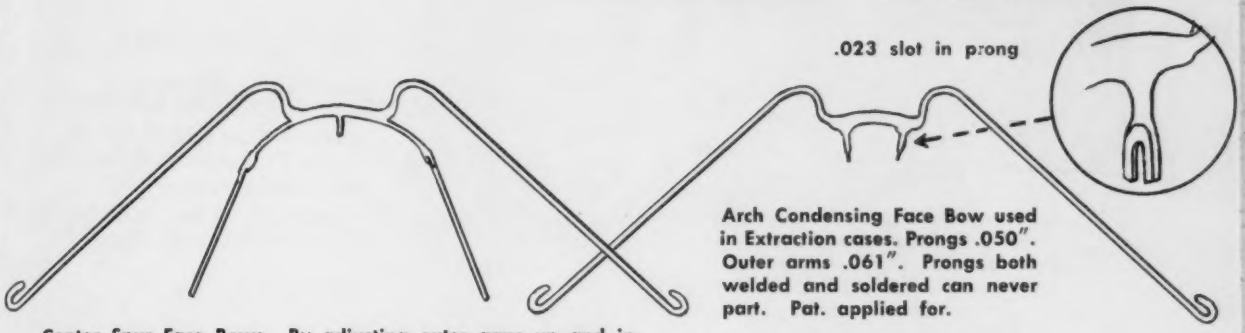

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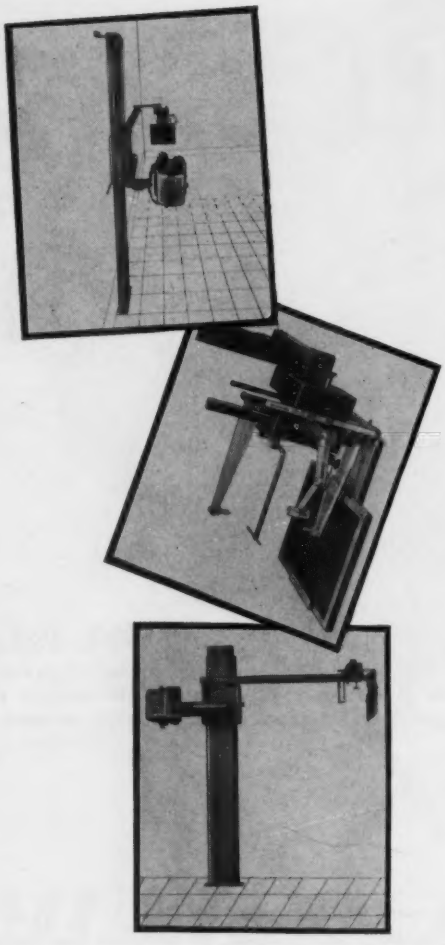

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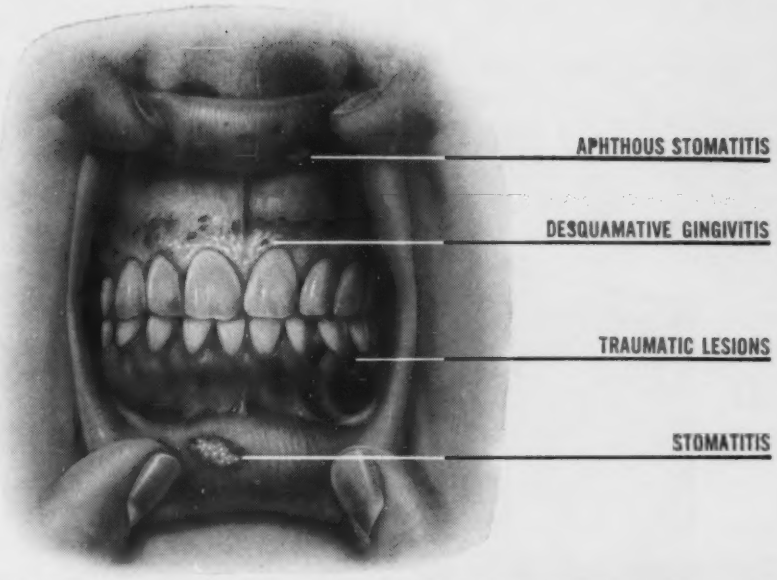

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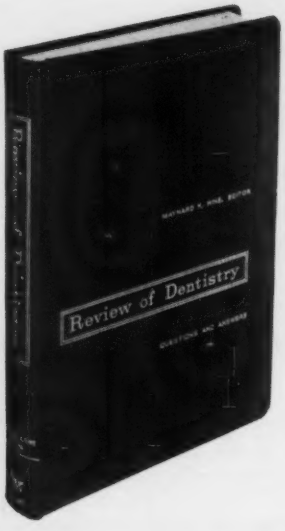

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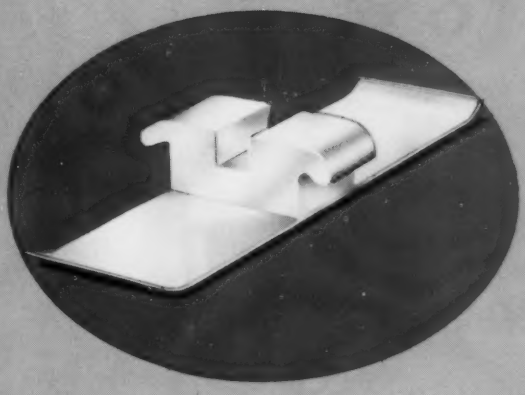

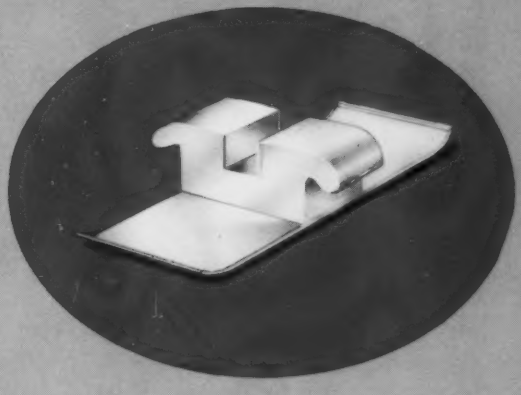

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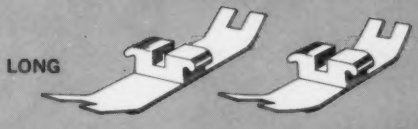

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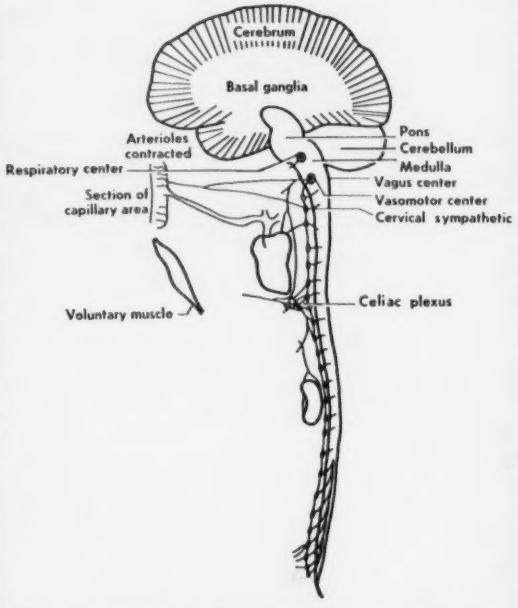

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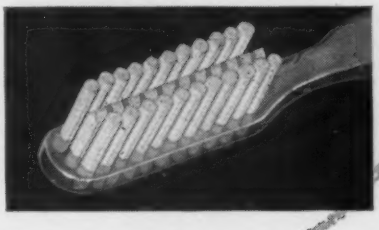

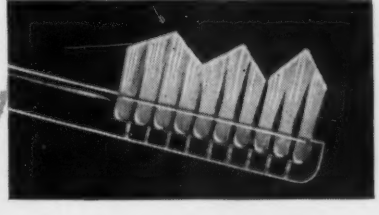

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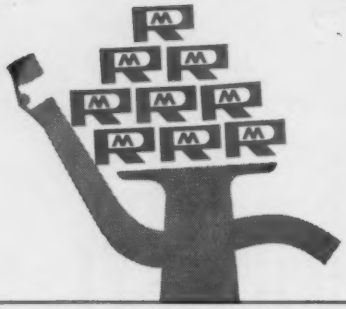

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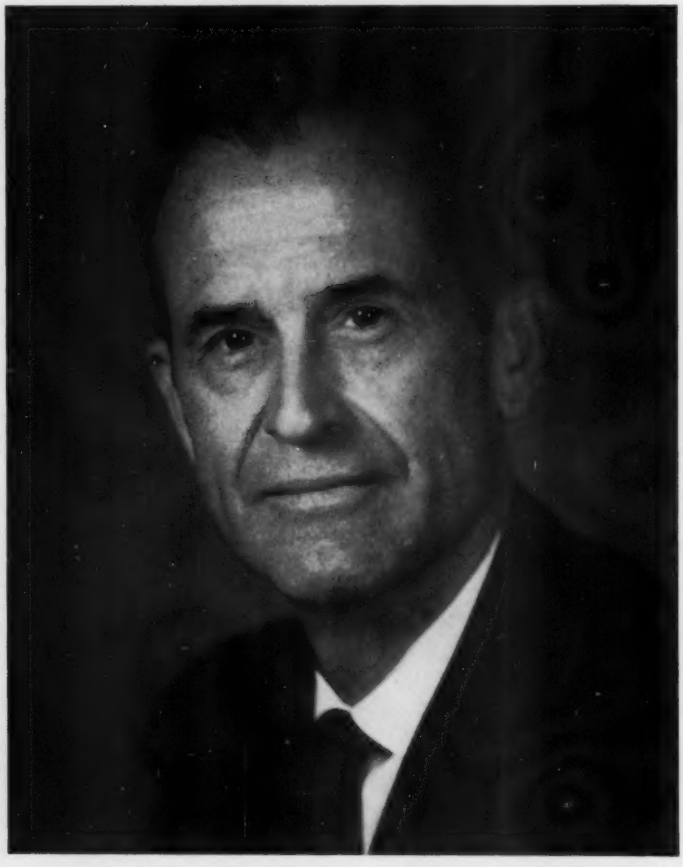

Dallas R. McCauley, Beverly Hills, California, president of the American Association of Orthodontists, 1961-1962.

American Journal of ORTHODONTICS

Volume 47, *Number* 7, JULY, 1961

ORIGINAL ARTICLES

Electromyography as an aid in diagnosis and treatment analysis

W. J. GROSSMAN, M.D., L.D.S., D. ORTH. R.C.S. (ENG.), B. E. GREENFIELD, B.D.S., F.D.S.R.C.S. (ENG.), AND D. J. TIMMS, L.D.S., D. ORTH. R.C.S. (ENG.)

London, England

THE urgent problem in orthodontic therapy today is not a mechanical one. Appliances have reached such a state of perfection that most malocclusions can be treated; the difficulty that still exists is the prevalent danger of relapse. The hope that present-day knowledge of etiology would permit a more precise prognosis in these cases has not been fulfilled. The uncertainty of treatment response and its final stability has no doubt been responsible for the various philosophies that have been put forward during recent years. Cases in which etiological factors appear to be similar respond differently, a fact that is well known to all who practice orthodontics. It seems, therefore, that the most important problem at present facing the orthodontist is to discover more about the etiology of malocclusion and about the changes that occur during treatment.

It is widely agreed today that muscular influences are partly responsible for the shape of the dental arches and that they are important factors in the final stability of the end result of orthodontic treatment. Certain abnormal muscle behavior patterns will result in typical and well-defined abnormalities, such as the short upper lip, the incompetent lip seal, the tongue-thrust, and the tight lower lip. These are all frequently seen and their importance is realized, but it is by no means universally agreed that they are not amenable to treatment or to re-education. The fact that some cases respond well to treatment and remain stable, even though initially they clearly present abnormal muscle behavior, suggests that an adaptation may have occurred. The great difficulty is the lack of an exact scientific assessment of existing muscle behavior prior to

From the Dental Department, University College Hospital, Great Portland Street, London, W. 1, England.

Read before the Research Section of the American Association of Orthodontists, Washington, D. C., April 26, 1960.

commencement of treatment which would enable the orthodontist to make a comparison and to assess any changes that may have occurred. Most reports are based on clinical observations which, in the case of experienced clinicians, are acceptable but nevertheless open to error.

It has, therefore, been thought worth while to try to assess these cases with the help of electromyographic investigations. So far this method has been of little value in studies of lip behavior. Tongue behavior has been studied with the help of x-ray cinematography. Many cases were investigated by this means, and tongue movements were carefully followed on a cine editor. No convincingly typical tongue behavior for any person was demonstrated, except for such activity as tongue-thrust in cases of gross abnormalities. The tongue-swallow described by Rix[12] and considered responsible for certain Class II, Division 2 cases could not be seen clearly in a single case.[7] So far, pressure-gauge examinations by different workers have also failed to produce clear results.[15, 16] We tried this approach, too, but it has not been possible to overcome the technical difficulties sufficiently to adapt the pressure-gauge examination for clinical studies. Dogmatic statements on treatment planning and prognosis, therefore, are not justified by our present-day knowledge of muscle behavior. Some of the abnormal muscle activities do disappear and may therefore be considered either as habits or as being amenable to re-education. Others remain and lead to relapse. So far, no satisfactory method of differential diagnosis has been found. It is felt that most of these cases should be treated on their own merits and that there is no justification for spreading undue pessimism and withholding treatment, even though treatment is planned on an empirical basis.

In the analysis of treatment results, one question that has been and still is of the greatest importance is: "How far can functional stimulation and environmental influences lead to changes in the masticatory organs?" Of particular interest to the orthodontist and the prosthodontist is the maxillomandibular relationship. The question of whether the mandible can change its position during treatment is a problem of fundamental interest. Häupl and his colleagues have shown, in animal experiments[8] and in the case of a child,[2] the changes that occur in the temporomandibular joint during orthodontic treatment. Most supporters of functional therapy have strongly advanced their views that the maxillomandibular relationship can be changed successfully with the help of appliance therapy.[1, 5, 10, 11] Others, however, deny this completely.[3, 9, 13] Although we have no intention of going into the theory of functional orthodontics, we consider it desirable to discuss this problem as it is seen today. Most statements are based on clinical observations, study models, and cephalometric roentgenograms. Cephalometric findings, however accurate, are often difficult to interpret, as it is sometimes impossible to differentiate between normal growth and development and changes produced by therapeutic measures. Björk[3] and Softley[13] tried to show, in a very few cases, that changes during functional orthodontics were restricted entirely to the alveolar bone. While their findings in these cases may be correct, the material was by no means sufficient to warrant far-reaching conclusions. During a recent examination of 200 treated patients, it was found that in 25 per cent there appeared to be a

change in the position of the mandible.[14] However, it is desirable to consider only those cases in which changes have occurred rapidly enough to exclude normal growth as a factor.

A new and efficient way of assessing maxillomandibular relationship has been sought, and it is believed that electromyographic examination of the masticatory muscles offers an exact and reliable scientific tool for making this assessment. It is today possible, by this method, to diagnose quickly any postural change in maxillomandibular relationship. Electromyography can also help in diagnosis and in treatment planning.

In 1956 Greenfield and Wyke[4] evolved a standard electromyographic technique which they used to study a series of basic mandibular movements in persons with normal occlusions. It was shown that each movement produced a characteristic electromyogram. Once this characteristic pattern had been established, it became possible to study malocclusion cases before, during, and after treatment. Cases in which orthodontic surgical procedures were performed were also examined. The effect of these different surgical procedures, such as osteotomy of the mandible, osteotomy and removal of condyles, etc., could be assessed by comparing electromyograms taken before and after the operations.

In these investigations a Grass electroencephalograph four-channel ink writer was used, but this has been replaced by an eight-channel machine which considerably shortens the investigation time and simplifies interpretation of the electromyograms.

The position of the electrodes used for monopolar recordings is shown in Fig. 1. Eight electrode positions are used; four electrodes are placed bilaterally—one over the anterior fibers of the temporal muscle, another over the posterior fibers of the temporal muscle, the third over the posterior superior fibers of the masseter muscle, and the fourth over the anterior inferior part of the masseter muscle. A reference electrode is placed just above the sixth cervical vertebra and the patient is also grounded.

Before any information can be gained from electromyograms, it is necessary that the electromyographic patterns usually seen in normal occlusions be fully understood. The unilateral recordings shown in Figs. 2 and 3 demonstrate the fundamental pattern of reflex muscle coordination for various movements recorded in a subject with normal occlusion. These electromyograms show the changes that take place when the teeth occlude in various centric and eccentric bites. At this point it should be stressed that a basic pattern of reflex muscle coordination for the individual bite is seen in normal persons, and frequently the same pattern is found in cases of abnormal occlusion. The individual bite shows that the muscle activity is optimum for all parts of the muscles under review. If the movements of the mandible are bilateral, then the changes in the electromyogram will also be bilaterally symmetrical. When the movements are eccentric, the electromyograms differ on the two sides; therefore, it is important that bilateral recordings be taken. When these basic patterns are analyzed, one can see that they fall into three main groups and two minor groups (the latter being of no less importance):

Major Patterns

1. The *individual bite* shows considerable activity of all the muscles under review, but the posterior masseter muscle shows less activity than the anterior masseter. The relative activity of the two parts of the masseter muscle is very important.

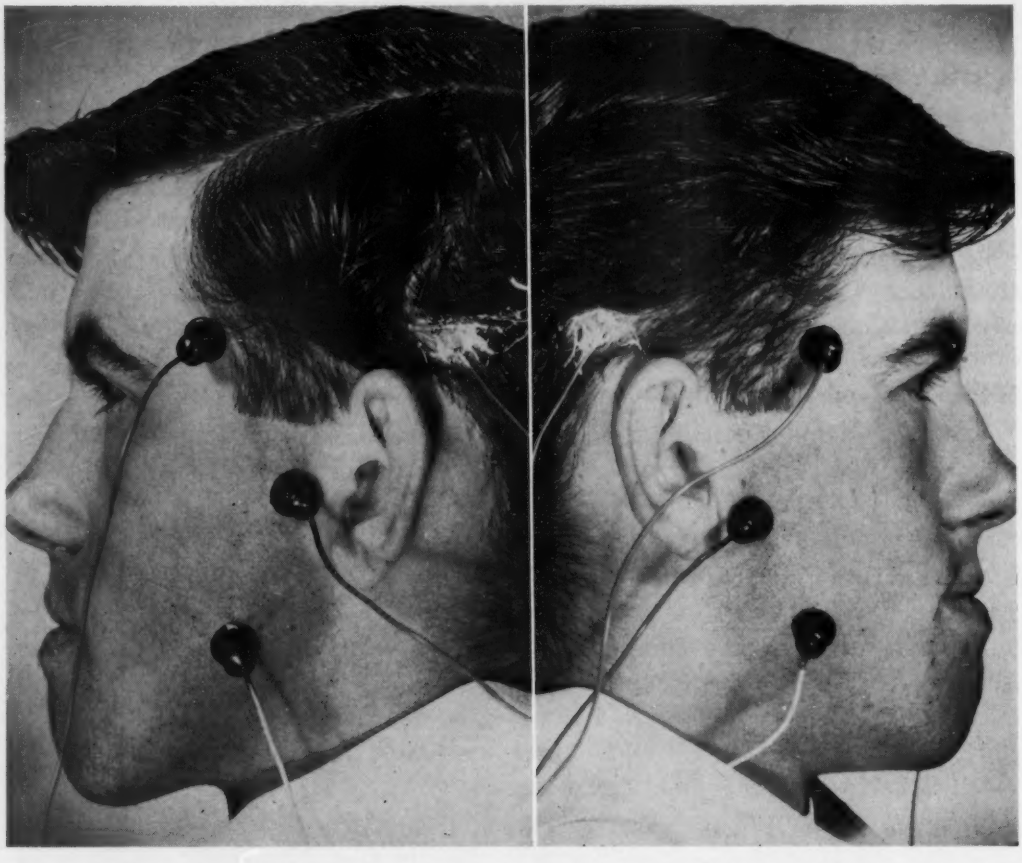

Fig. 1. Bilateral positioning of surface electrodes. The electrodes over the anterior temporal and masseter muscles are retained by means of suction cups. It is sometimes necessary, as shown in this case, to use colloidin to fix the electrode over the posterior temporal muscle.

2. When the mandible comes forward into an *incisor bite,* or even further forward into a *protrusive bite,* then the activity of the posterior temporal muscle drops considerably. Slight varying activity is seen in the anterior temporal muscle, depending on the force of the bite. The activity of the masseter muscle changes very little, and the relationship of activity of the two parts of this muscle stays the same.

3. Biting in a forced *retrusive* position shows high activity of the posterior temporal muscle and slightly lower activity of the anterior temporal muscle, but the greatest change in activity is seen in the

anterior masseter muscle; the activity of this part of the muscle drops. The posterior part of the masseter muscle now shows greater activity than the anterior part (or at least equal activity).

Minor Patterns

4. In *protrusion without biting* it is seen that the posterior masseter muscle shows the greatest activity.

5. In *retrusion without biting* the greatest activity is now seen in the posterior temporal muscle.

Eccentric bites or movements produce myograms that differ on the two sides. During left biting, for example, the pattern on the ipsilateral side looks like that of the retrusive bite and the pattern on the contralateral side looks like the incisive or protrusive biting pattern.

The patterns shown in Figs. 2 and 3 are perhaps those of the ideal occlusion, but many normal occlusions show slight variations. It has been found that closer clinical investigation frequently reveals the reason for these slight variations in myographic patterns in cases of so-called normal occlusion. Myograms recorded in a few cases of malocclusion will demonstrate the practical application of this method.

In a Class II, Division 2 case treated with an activator, the working bite was taken in a protrusive position. Electromyography revealed that with the activator in position all the muscles showed reduced activity, but the greatest reduction had taken place in the posterior temporal muscle; this, in fact, is the pattern of protrusive biting (Fig. 5).

After two years of treatment the individual bite shows a tendency to protrusive biting, even when the patient is not wearing the activator (indicated by reduced posterior temporal muscle activity). With the activator in position, a further reduction of posterior temporal muscle activity takes place. Once again, when the activator is removed and the patient is instructed to attempt a firmer individual bite, it is seen that the posterior temporal muscle now shows increased activity (Fig. 6).

In order fully to understand the apparent contradiction of the two muscle patterns shown in Fig. 6, we instructed the patient to perform an individual bite with increasing force. This record, which was registered on paper moving at 60 mm. per second (Fig. 7), shows that the bite is in two phases. The initial bite is protrusive, with low temporal muscle activity, and the latter part of the bite is the normal pattern for individual biting. The bite of preference, however, is the slightly protrusive bite with low posterior temporal muscle activity.

In some cases, monitoring the activity of the muscles by means of electromyography shows that the pattern returns to normal. This means that either the mandible has returned to its original position, which can sometimes be excluded by clinical and cephalometric findings, or the muscles have adapted themselves, perhaps by changes in their areas of insertion, in response to functional influences.

Fig. 2.

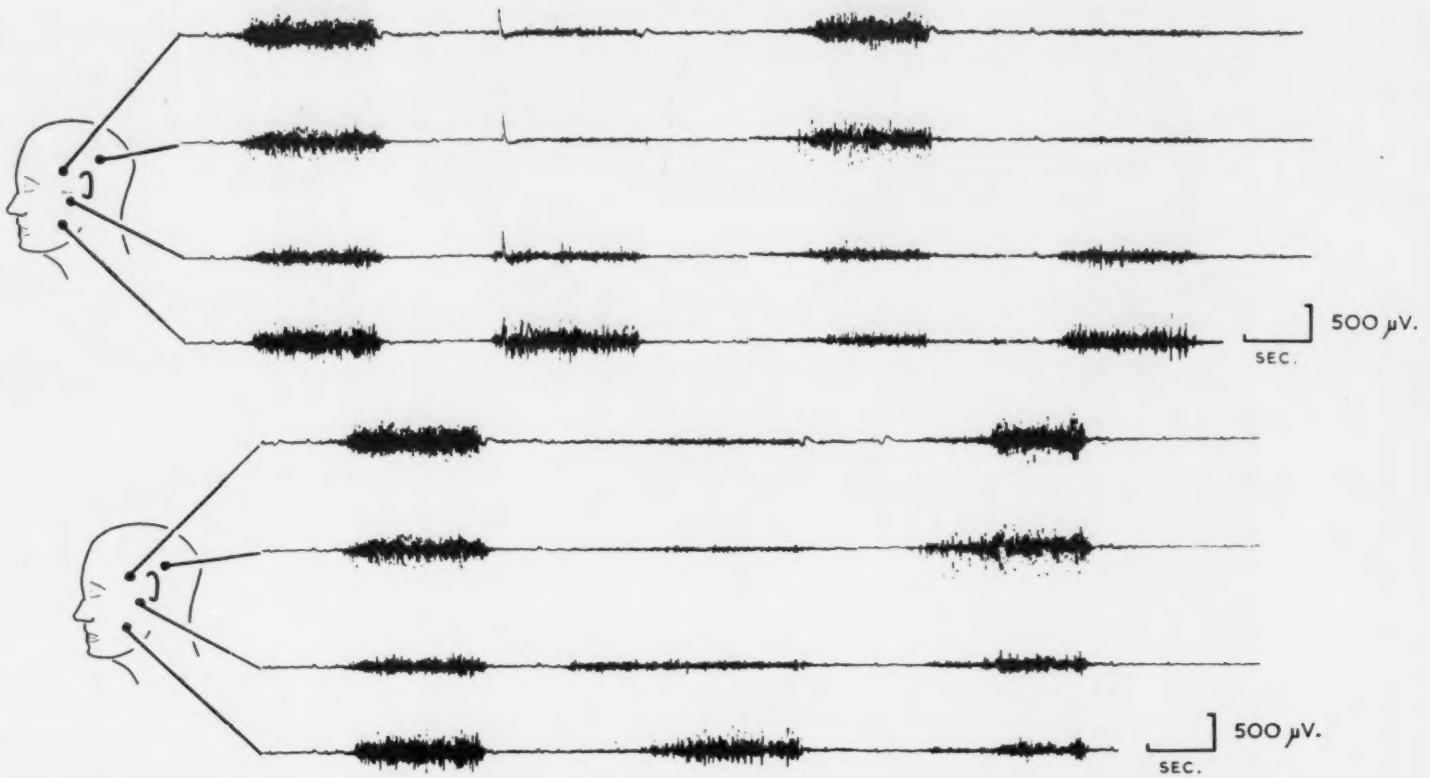

Fig. 3.

Fig. 2. Unilateral myograms, recorded on the left, showing the activity of the anterior and posterior temporal and masseter muscles during the individual, incisor, left, and right bites.

Fig. 3. Unilateral myograms comparing the activity of the muscles on the left side during the individual bite, protrusion, protrusion with bite, retrusion, and retrusion with bite.

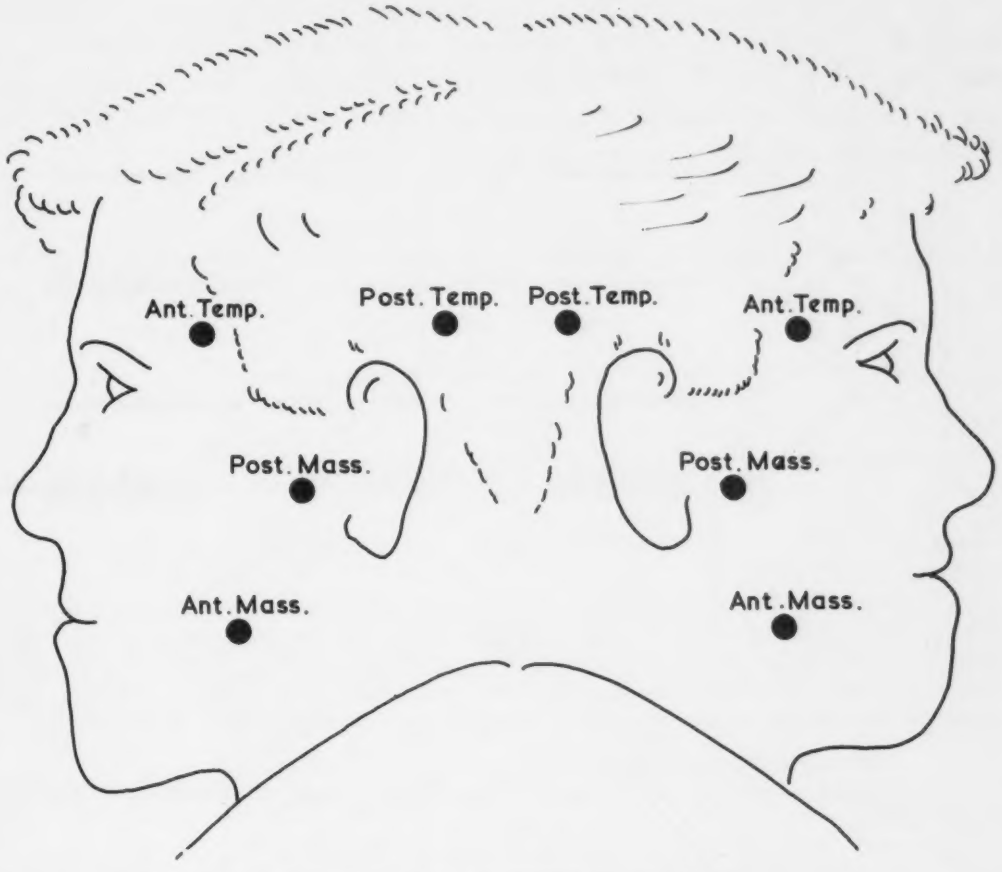

Fig. 4. The eight electrode positions used for monopolar recordings.

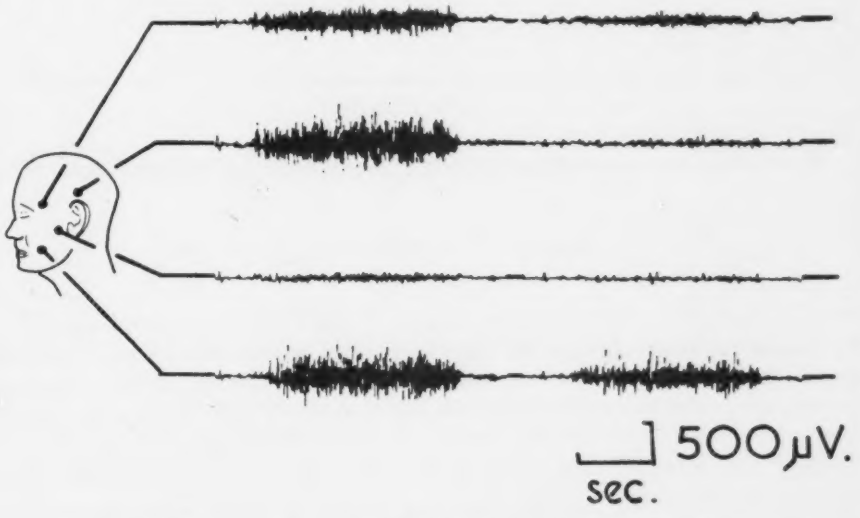

Fig. 5. Class II, Division 1 case at beginning of treatment. The first myogram shows a unilateral recording of the individual bite. The second myogram demonstrates the great reduction that has taken place in posterior temporal muscle activity during biting with the activator in position.

In Class II, Division 2 cases electromyography has contributed to an understanding of some of the problems involved. A well-known clinical observation has been that in some of these cases the mandible seems to move forward, once the upper front teeth have been proclined. Two of us (W. J. G. and B. E. G.),

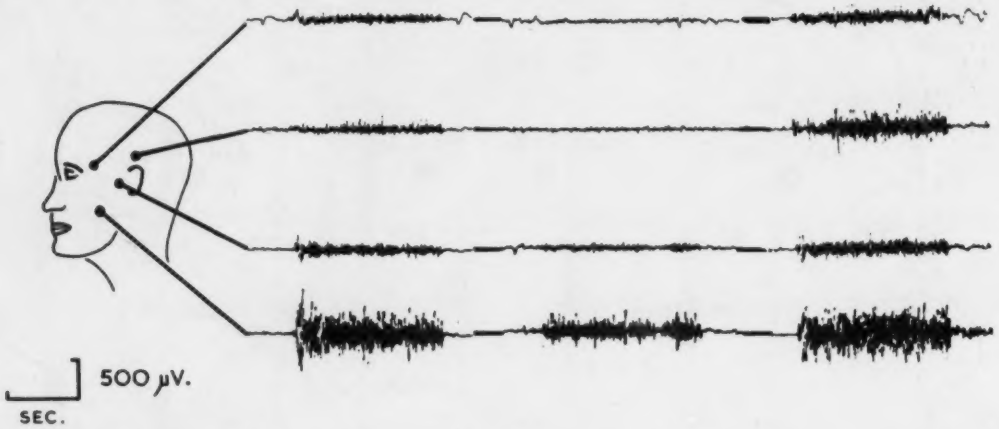

Fig. 6. The same Class II, Division 1 case as shown in Fig. 5, after two years of treatment. The first myogram shows the individual bite with low posterior temporal muscle activity. The second shows that biting on the activator further reduces this posterior temporal muscle activity. The third myogram shows that, with the activator once again removed, the patient is capable of high posterior temporal muscle activity when biting.

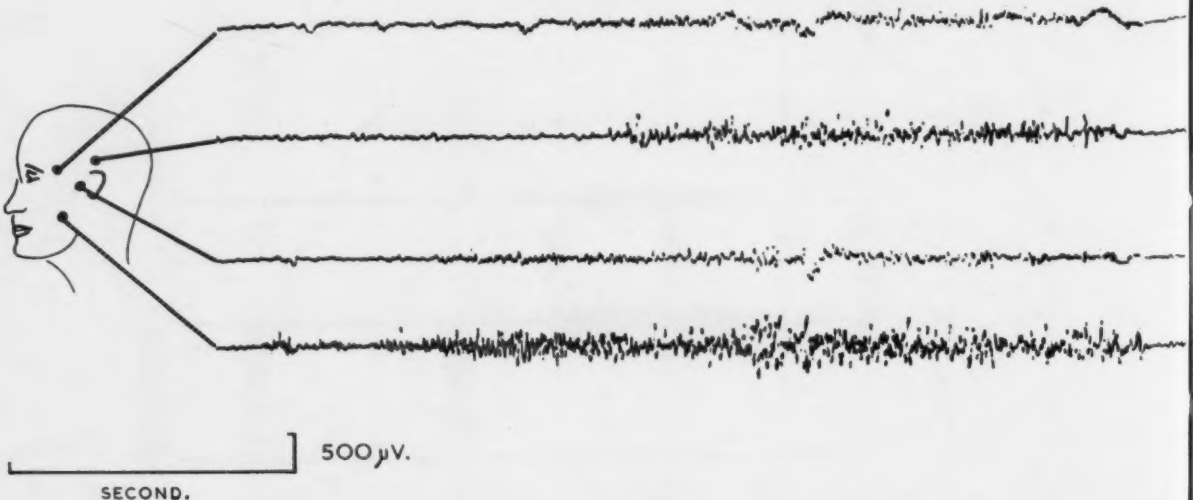

Fig. 7. The same Class II, Division 1 case recorded at the same time as the myograms in Fig. 6. This myogram records the individual bite with increasing force (recorded at 60 mm. per second). The two-stage individual bite is seen. The early stage of the bite shows low posterior temporal muscle activity and is protrusive; the second part of the bite is more normal, showing greatly increased posterior temporal muscle activity with hardly any increase in anterior masseter muscle activity.

in an electromyographic examination of Class II, Division 2 cases, have found that 15 per cent of these patients show a distal displacement pattern before treatment is commenced (Fig. 8).[6] After proclination of the upper incisors, the

myogram became normal, confirming forward movement of the mandible (Fig. 9). The distal relationship seen in these Class II, Division 2 cases is sometimes only unilateral. The result of treatment also shows many variations of final jaw relationship.

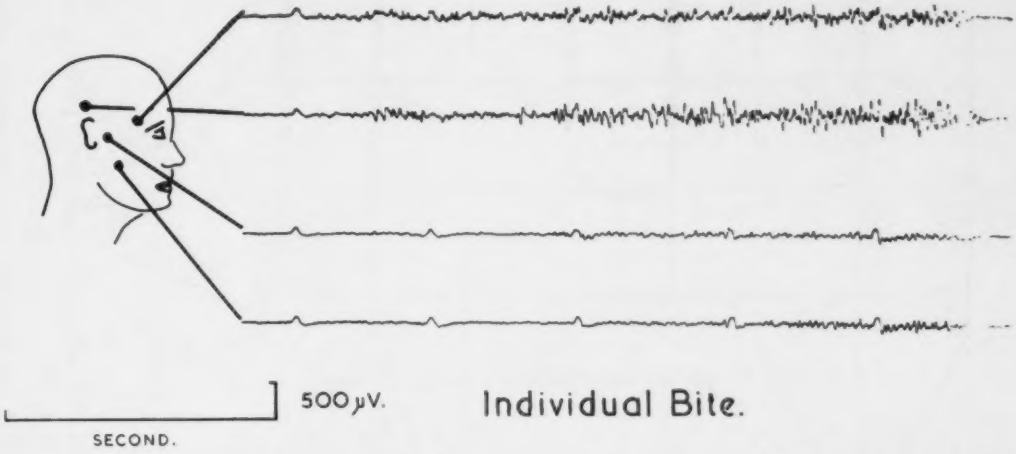

Fig. 8. Class II, Division 2 case at beginning of treatment. In this case there is a distal position of the mandible on the right side. Note the low, late activity of the anterior masseter muscle in the early stages of biting as compared with the activity of the posterior temporal and posterior masseter muscles.

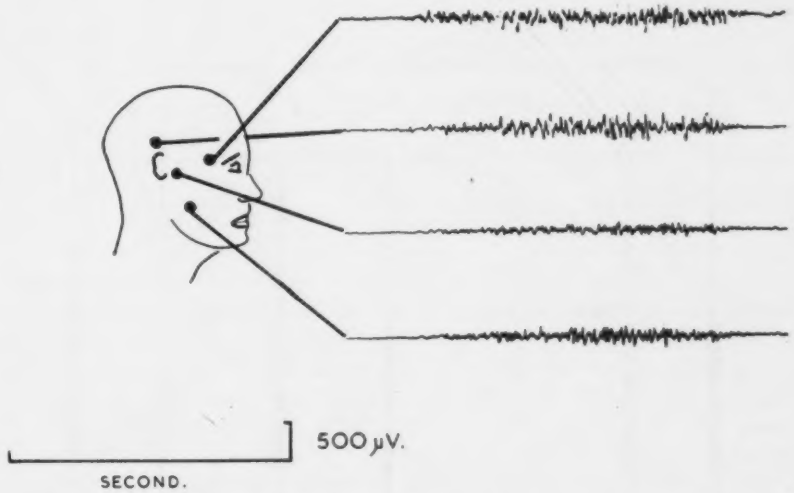

Fig. 9. The same case as shown in Fig. 8, after treatment. The mandible is no longer in a distal position. The activity of the anterior masseter muscle commences at the same time as that of the posterior temporal muscle and at all times is greater than the posterior masseter muscle activity.

This initial distal relationship before treatment is seen in another Class II, Division 2 case (Fig. 10), in which a mesial relationship is finally apparent after treatment. The case shown in Fig. 11 has remained stable for over two years, with the muscle pattern seen at the end of treatment showing no further change. Thus, an abnormal muscle pattern (retrusive before treatment) has

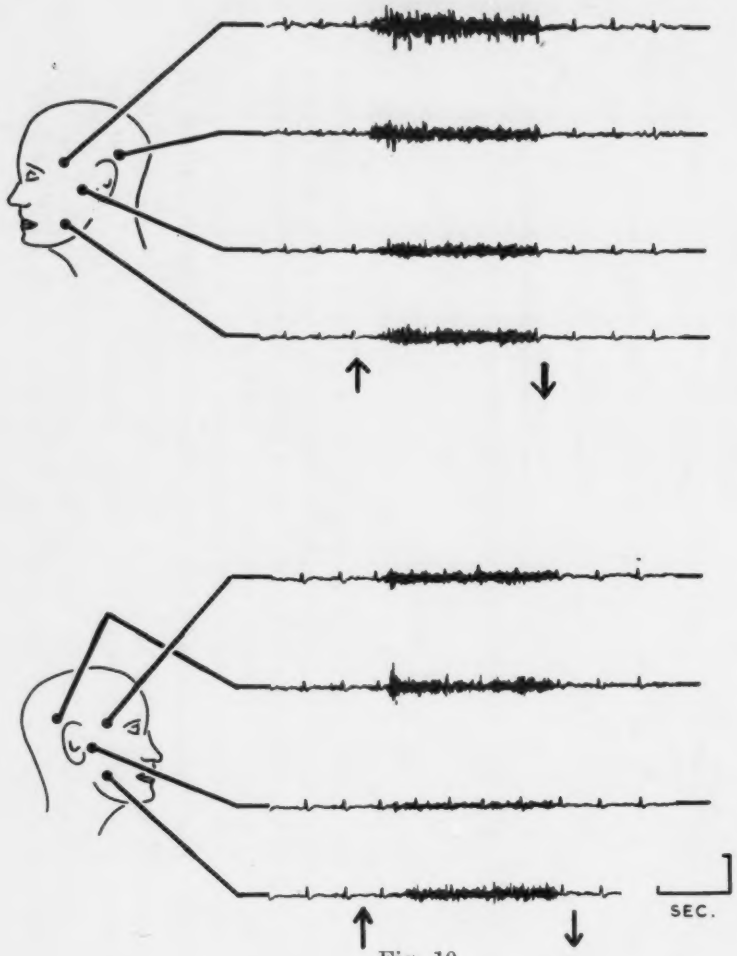

Fig. 10.

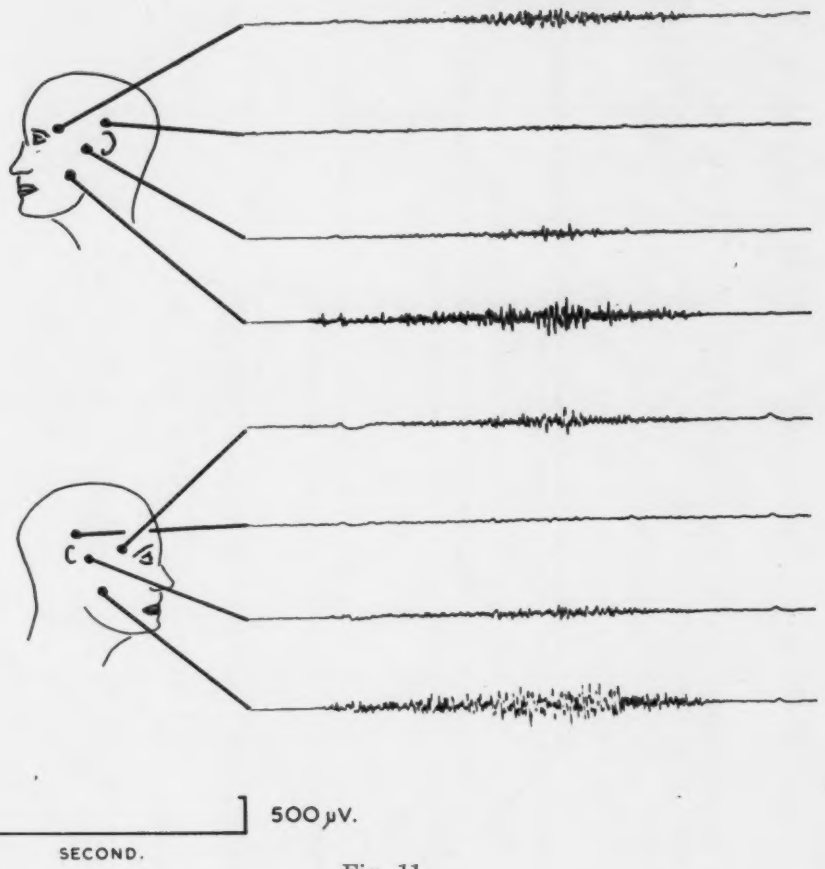

Fig. 11.

Fig. 10. Class II, Division 2 case showing bilateral early posterior temporal muscle activity indicative of a distal position of the mandible before treatment.

Fig. 11. The same Class II, Division 2 case as shown in Fig. 10. Note the late activity of the posterior temporal muscle, indicating a prenormal position of the mandible after treatment.

become, after treatment, a fairly normal muscle pattern (slightly protrusive). In Fig. 12 this patient's range of mandibular movement is clearly shown. The first two myograms represent incisor bites. The third myogram (of longer duration) is produced when the patient performs the individual bite, increases the force of the bite, and then slides the mandible into a forced distal occlusion.

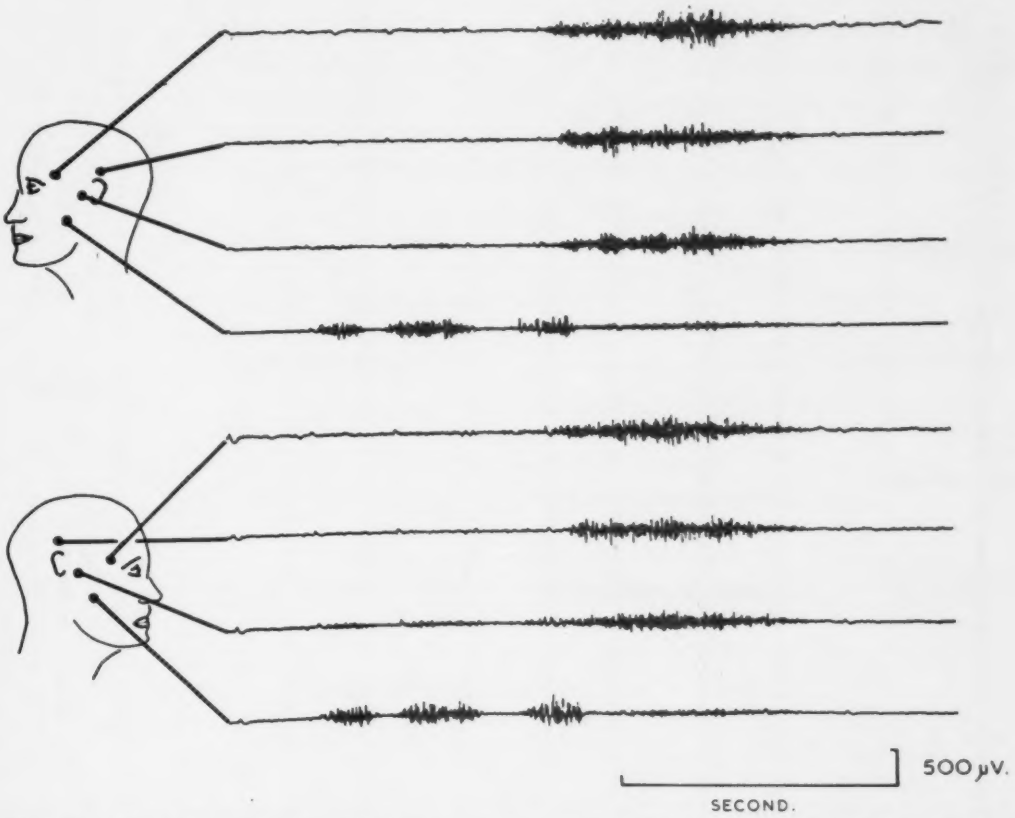

Fig. 12. The same Class II, Division 2 case as represented in Figs. 10 and 11, showing the electromyographic patterns for (1) two incisor bites with low temporal activity and (2) the individual bite sliding into a forced retrusive bite (3). In this movement the low posterior temporal muscle activity and the high activity of the anterior masseter muscle in the early individual bite are seen to change into the equally high activity of all the muscles in the later stages of the individual bite. Finally, the lowering of the anterior masseter muscle activity as the mandible is voluntarily retruded may be seen, whereas both parts of the temporal muscle and the posterior masseter muscle remain very active in this distal jaw relationship.

Fig. 13 shows myograms taken before and after treatment in a Class II, Division 2 case in which the lower incisors were proclinated, resulting clinically in a normal occlusion. The myogram recorded before treatment (upper tracing) shows the slow onset of activity of the posterior temporal muscle; this is in the range of normality but most likely indicates incisor biting in the early stages of closure. After treatment, however, the myogram (lower tracing) revealed a distal displacement during closure from rest to occlusal position. The

Fig. 11. The same Class II, Division 2 case as shown in Fig. 10. Note the late activity of the posterior temporal muscle, indicating a p
position of the mandible after treatment.

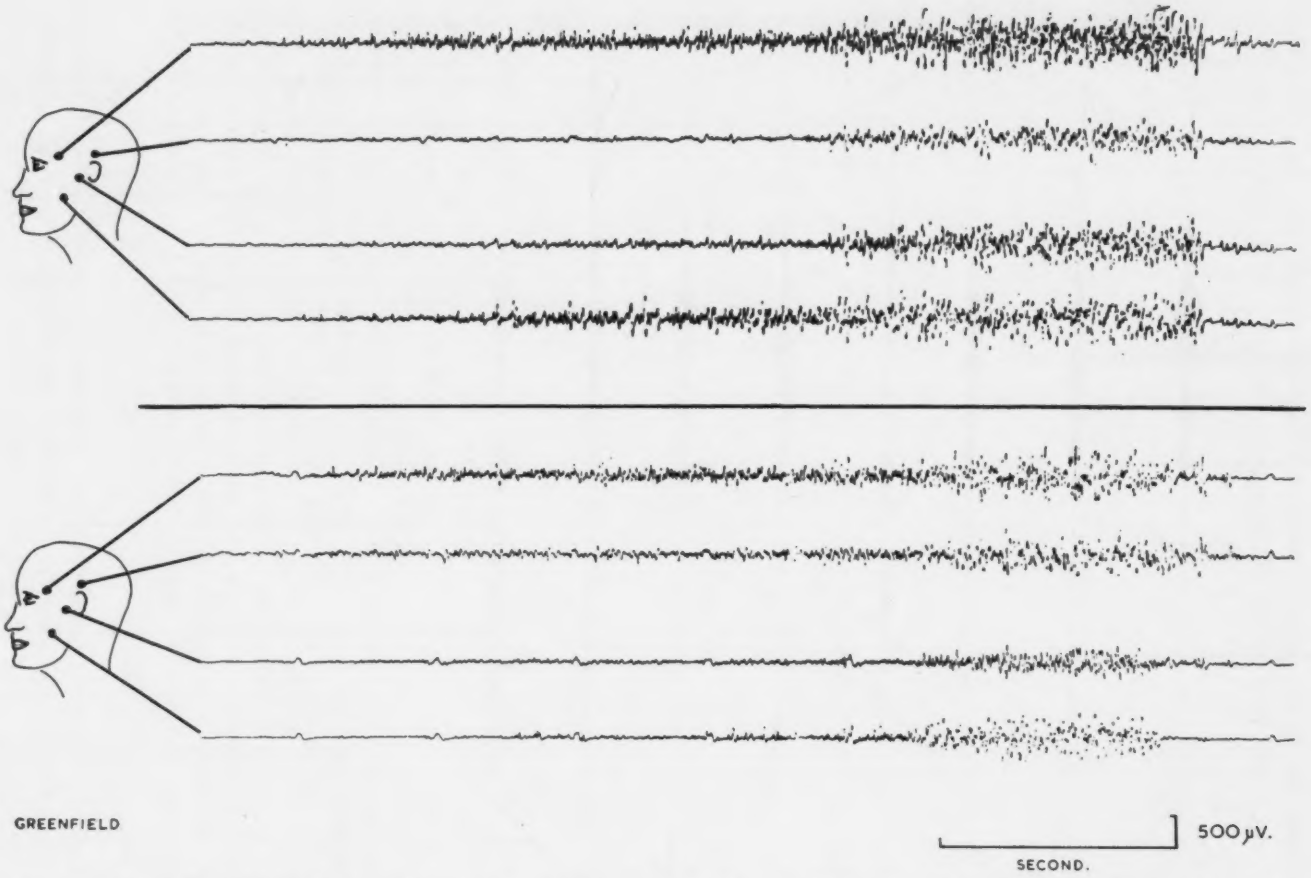

Fig. 13. Class II, Division 2 case. The upper tracing prior to treatment shows late posterior temporal muscle activity in the early stages of closure. The lower tracing, recorded after treatment, shows the change to early posterior temporal muscle activity and late anterior masseter muscle activity in early stages of biting, indicating a distal relationship of the mandible in this initial stage. Both before and after treatment the relationship of the mandible is normal, once the molars are in contact.

final occlusal position was normal. This means that the mandible had to be retracted to allow the lower front teeth to slide behind the upper front teeth. It is in this type of case that a continuous abnormal incisal contact leads to abrasion of the mandibular incisors and an edge-to-edge bite occurs; only after attrition does the mandible become correctly positioned during the whole path of closure.

In the treatment of Class III cases with the sliding activator, changes in muscle activity were demonstrated from the time treatment commenced. In Fig. 14 the effect of the activator is shown. Very soon after the treatment was initiated this prenormal relationship was changed to an edge-to-edge incisor bite. The first tracing shows the low anterior masseter muscle activity and the

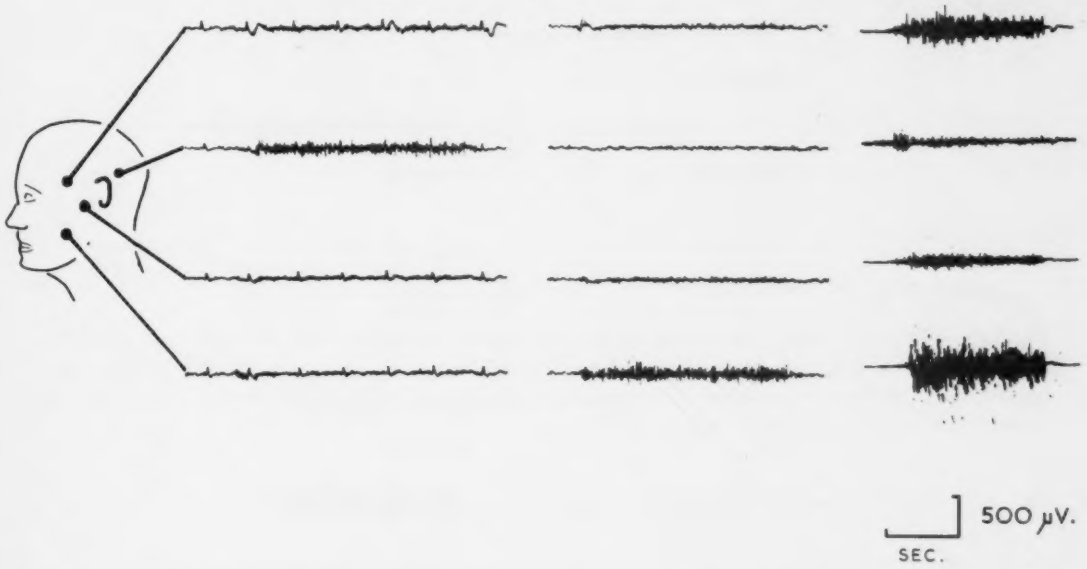

Fig. 14. Three myograms of the individual bite of a Class III case treated with a sliding Norwegian plate show the transition during treatment. The stages seen are (1) post-normality (posterior temporal muscle active), (2) slight prenormality (anterior masseter muscle active), and finally (3) normal maxillomandibular relationship (all muscles active).

comparatively high activity of the posterior temporal muscle, clearly indicating that a distal mandibular relationship was being achieved. The second tracing shows that, once the upper incisors had come over the lower incisors, the posterior temporal muscle activity was no longer predominant, the mandible now being in a normal or possibly slightly prenormal position. The third myogram, taken after completion of treatment, shows very active muscle activity for the initial bite; in this particular case a normal maxillomandibular relationship had been established, as far as muscle balance was concerned.

Unfortunately, in many Class III cases, although they respond to treatment, normal electromyograms are never achieved. Fig. 15 shows myograms recorded after completion of treatment of such a case. The individual bite shows very low anterior masseter muscle activity, which means that the mandible

is in a distal relationship. (This can be confirmed by instructing the patient to bring the mandible forward and to bite with the lower incisors in front of the upper incisors.) In the second tracing, the protrusive bite shows that the anterior masseter muscle is capable of activity if the mandible is allowed to come

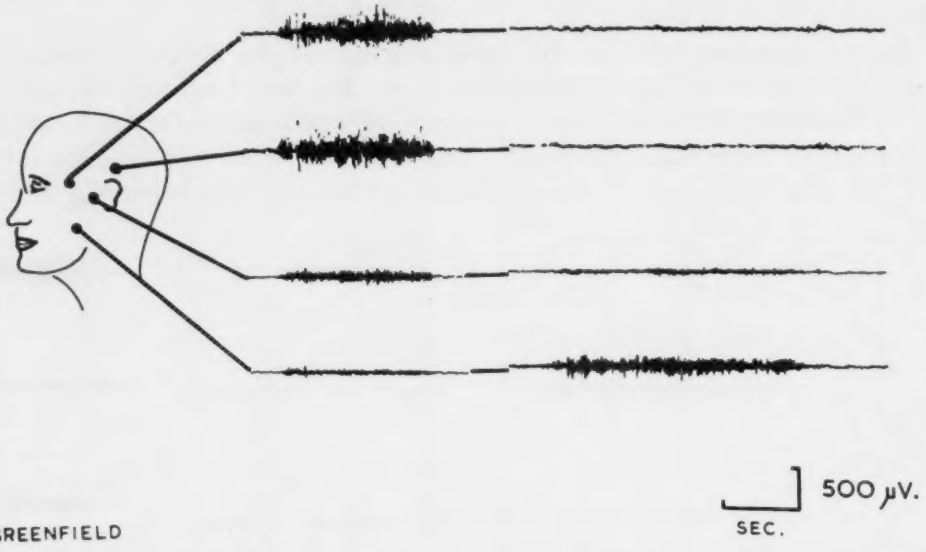

Fig. 15. Treated Class III case showing the final individual bite to have low anterior masseter muscle activity, indicating a forced retrusive bite. The myogram of a voluntary protrusive bite showing anterior masseter muscle activity helps to emphasize the abnormal muscle pattern for this final individual bite.

Fig. 16. Myograms of the individual bite of a Class III case treated surgically. The first myogram shows the preoperative bite. The second myogram shows the low activity of the anterior masseter muscle in the postoperative individual bite. This second pattern indicates a postnormal maxillomandibular relationship.

forward. Neither mandibular biting position, however, is correct. The first tracing shows the mandible to be in a forced distal position with high posterior temporal muscle activity and low anterior masseter muscle activity, whereas the second tracing shows it to be in a mesial relationship with high anterior masseter

muscle activity and very low posterior temporal muscle activity. This result can be confirmed very easily by clinical palpation of the anterior temporal and masseter muscles. In the individual bite position the temporal muscle can be felt whereas the masseter muscle cannot, and in the protrusive position the masseter can be felt but not the temporal muscle. In successfully treated cases in the individual bite position, both muscles are equally active.

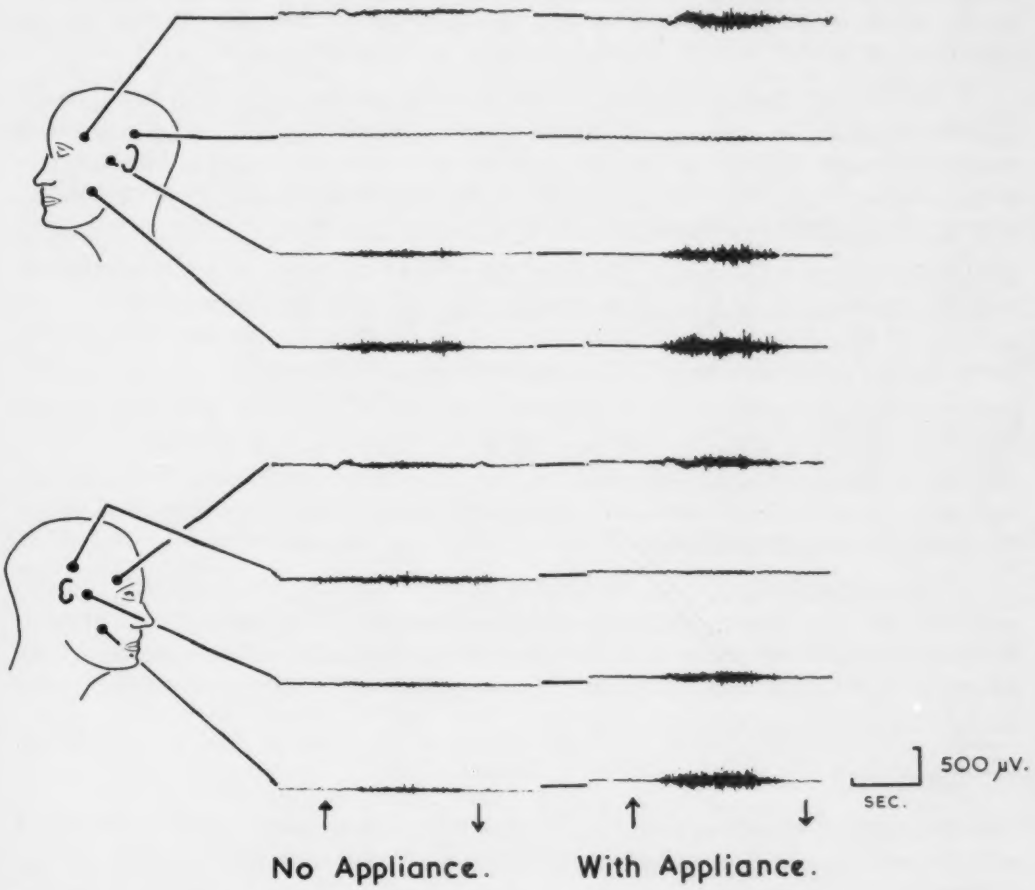

Fig. 17. A case of temporomandibular joint disorder showing the effect of a bite positioner on an unbalanced occlusion.

The foregoing case shows an end result very similar to that obtained in a Class III case corrected surgically by the Kostecka method of bilateral osteotomy of the ascending ramus. The myograms in this case, before and after treatment, are shown in Fig. 16. The first tracing shows a fairly normal myogram for the individual bite. The second tracing, made after surgical treatment and after removal of the splints, shows a very low anterior masseter muscle activity. This low activity, associated with the high posterior temporal muscle activity, indicates a distal relationship of the mandible.

Thus, in some Class III cases the mandible showed a distal displacement even after completion of treatment. In other cases the myogram became normal

and also showed normal occlusal balance. In those cases in which the myogram was not normal after treatment, either the muscles had not adapted themselves or the mandible was mechanically held back by a changed position of the teeth. These latter cases are being kept under review for possible relapse.

In some cases of temporomandibular joint disorders, electromyography has revealed abnormal muscle patterns with associated malocclusion. The pattern frequently shown in these cases is one of deviation of the mandible to one side or the other on initial closure of the mandible from the rest position to the habitual bite.

The first myogram in Fig. 17 shows that the muscle pattern is unbalanced. On the left side the posterior temporal muscle activity is low and the anterior masseter muscle activity is high, whereas on the right side there is late anterior masseter muscle activity and early posterior temporal muscle activity. This deviation of the mandible to the right may or may not have been the cause of pain in the temporomandibular joint. This case was treated by means of a bite positioner, and the second part of Fig. 17 shows the effect of this appliance on the muscle activity during biting. Treatment resulted in bilateral symmetry. Clinically, there was also a cessation of painful temporomandibular joint symptoms. The posttreatment myogram shows a bilateral lowering of posterior temporal muscle activity, indicating that the bite is protrusive. In some of these cases in which the electromyographic investigation shows a balanced occlusion, the only abnormality recorded is a constant continuous firing of one or other or both of the posterior temporal muscles.

Electromyography of the muscles of mastication has become a very useful scientific tool for use in diagnosis and in assessment of orthodontic treatment. It must not be used alone, however; only in a well-balanced combination with all other known methods of clinical investigation will electromyography prove useful in attempts to solve our problems.

SUMMARY

Present-day knowledge of etiology has not, as had been hoped, produced a reliable orthodontic prognosis. It is recognized that muscular activity of the soft tissues influences the shape of the dental arches. It is debatable, however, whether or not these influences can be changed and whether, if changed, they can remain as stabilizing influences for any corrected arrangement of the teeth. Various diagnostic aids, including electromyography, cineradiography, and pressure-gauge examinations to assess soft-tissue behavior, have been tried, with little positive clinical success.

Electromyography of the muscles of mastication has proved useful in determining the maxillomandibular relationship.

In the present report standard basic myograms for various jaw movements have been shown, and examples of changes in these myograms that can be expected to accompany treatment of various orthodontic abnormalities have been shown and discussed.

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Second and third molars: their role in orthodontic therapy

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IN THE light of present-day orthodontic thinking, is there a useful role for the third molars? Can there be justification for the removal of second molars with the expectation of their satisfactory replacement by the third molars? Do second molars make suitable replacements for first molars that have been lost? In suitable cases is the load on anchorage units lessened?

The purpose of this discussion is to attempt to answer the above questions, with due consideration being given not only to the indications but also to the all-important contraindications.

Throughout the history of orthodontics there have been numerous discussions regarding extraction and nonextraction of teeth prior to, during, or subsequent to orthodontic therapy. The philosophies proposed in the past have been advanced with an enthusiasm that was equaled only by those who opposed them and each era in our orthodontic progress has produced authorities who have influenced our thinking on the subject. In 1839 Spooner[1] advised the extraction of four premolars in many cases; he also advised that first molars be removed in cases of defective structure or when these teeth were broken down by early decay. Farrar,[2] in 1888, considered "judicious extractions as one of the most essential requisites for the prevention and correction of irregularities." He warned, however, that indiscriminate extraction may "create a new difficulty while removing the original one."

In 1907 Angle[3] presented the opposite philosophy, namely, "that the demand in treatment should be the removal of pernicious causes, and the retention of a full complement of teeth." While his teachings did not stop all discussion of

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extractions, they had a marked influence on the thinking of leading orthodontists for many years. The advent of gnathostatics, and later of cephalometric appraisals, brought a fuller concept of facial development and the possible limitations of basal bone. This, in turn, aided in bringing about a reappraisal of the question of extractions and their place in orthodontic therapy. Tweed,[4] Nance,[5] and Dewel[6] have done much to make the orthodontic profession aware of these limitations. They have given valuable aid in bringing about solutions to many of our problems concerning the amount of tooth structure permissible in individual patients, placing of the denture within the available basal bone, and the relationship of the whole to the enveloping muscular tissues. Thus, the cycles of extraction and nonextraction keep turning, but with each revolution additional knowledge is gained and better orthodontic results are obtained.

This article is not presented in support of any theory of universal extraction in all cases. Nor is it presented as an argument favoring nonextraction during orthodontic therapy. The purpose is to submit facts in support of the original thesis introduced in 1918 by Morehouse[7] relating to third molars in orthodontic therapy and also to present additional evidence of the useful purpose served by second and third molars in many cases.

AREA OF INTEREST

The area of immediate concern is the maxillary tuberosity and the room available for eruption of the maxillary second and third molars. During growth of the maxillae, space to accommodate the erupting first, second, and third molars must be created by growth in the posterior region of the tuberosity. The maxillary growth in this area must normally be downward and forward to create room for the eruption of each succeeding molar. If growth in this region is insufficient, abnormal eruption or lack of eruption will be the result. It is not unusual to see maxillary second molars erupting in bucco version because of a lack of development in the tuberosity area. They must either erupt in this manner or be impacted, and this condition is magnified with respect to available room for eruption of the maxillary third molars. This situation is accounted for in part by Weinmann and Sicher[8] when they report that the "gradual reduction in length of the jaws and the reduction of the dentition are not entirely correlated" and indicate that in some future generation we will not have to contend with third molars. In the meantime, it may be possible to turn the discounted third molar to some advantage as a substitute for the second molar in certain situations and at the same time solve some of our problems in the maxillary tuberosity area.

The early orthodontic interception of Class II malocclusions by means of occipital anchorage and simple appliances, as advocated by Kloehn, made it possible to aid in directing growth and simplifying secondary treatment. In treatment of the average malocclusion, however, the orthodontist is faced with the fact that many of the cases are presented at an age when there is comparatively little growth potential remaining; therefore, the problem deals more directly with tooth movement within the confines of the dental arches. In this

event, an evaluation must be made of the possible growth potential, and this evaluation must then be balanced against the amount of growth needed for the eruption, or movement, of the remaining teeth. At times this problem becomes rather acute in the region of the maxillary tuberosity. In Class II nonextraction cases, the amount of development distal to the maxillary second molars is of paramount importance. Without the needed room to move the maxillary denture posteriorly until a normal relationship with the cranial anatomy is restored, an impasse is often reached. The usual result is a buccal displacement of the maxillary third molars and, at times, a displacement of the second molar. This is undesirable, for the extra burden of attempting this movement into a crowded maxillary tuberosity often results in a dislodgment of the mandibular anchorage, especially if total intermaxillary traction is used. Hopkins[9] has emphasized this fact many times in his discussions of the inadequacy of mandibular anchorage. Regardless of the type of case, stability of the denture may be seriously jeopardized if the situation is ignored.

The restrictions imposed on the operator by lack of room in the maxillary retromolar area were graphically portrayed by Dillon[10] in a report dealing with the removal of 28,000 maxillary third molars. Prior to extraction 9,000 of these teeth were impacted with no room for eruption, 9,000 had erupted bucally, and the remainder were removed because of carious involvement or partial eruption. The patients were presumably of an age at which all growth of the dental components would be complete, and no doubt all types of occlusion were represented. The findings in these patients should form a good projection, in terms of years, of the conditions found in many patients prior to orthodontic treatment.

All areas of growth should be considered in an evaluation of the possibilities in orthodontic therapy. For the moment, however, the major interest will be focused on the sites affording eruption of the second and third molars. An attempt will be made to demonstrate a practical method of relieving the congestion in the maxillary tuberosity, thereby aiding in stabilization of the denture and at the same time replacing often decalcified and carious molars with sound tooth structures. Although the majority of our cases involve the maxillary tuberosity area, an effort will be made to demonstrate that second and third molars may be valuable as dental components in the mandibular posterior areas as well.

FACTORS INFLUENCING SECOND OR THIRD MOLAR EXTRACTIONS

The purpose of this discussion is primarily to demonstrate the feasibility of using the third molar as a substitute for the second molar in certain cases. This is not a universal panacea for orthodontic problems, but it is extremely valuable when used with mature judgment. The dental age of the patient, the position occupied by the teeth in question, the state of dental care of the posterior segments, and the future stability of the denture are factors which must be considered carefully before any decisions are made. The prognosis for successful results is excellent if the indications are respected, but the contraindications are so important that they also must be carefully assessed in each case.

The indications for eliminating the maxillary second molar and replacing it with the third molar are as follows:

1. Maxillary third molars of fair size and shape, with the possibility of good root development.
2. Small, restricted maxillary tuberosities and the possibility of interference with distal movement in the maxillary posterior region.
3. Second molars erupted buccally.
4. Second molars decayed, badly decalcified, or having large restorations.
5. Maxillary third molars in favorable position and angulation relative to the second molar and the maxillary tuberosity.
6. Maxillary third molars in favorable relation to the mandibular second molars.
7. Desirability of relieving the anchorage units of an overload.

The replacement of maxillary second molars will be considered in both Class I and Class II malocclusions. The majority of these cases will be of the Class II variety, but other classifications should not be ruled out. The rules enumerated above or for general consideration and, although some leeway may be allowed under certain conditions, the indications should be carefully checked before treatment is begun. I am of the opinion that failure to consider the total picture regarding the subject can often result in failure to obtain the results desired and defeat the purpose of the treatment procedure. Therefore, the contraindications are, at times, more important considerations than the routine indications. In general, the contraindications will be the opposite of the criteria used for indications, but a few must be particularly emphasized. They are as follows:

1. Maxillary third molars too high in the tuberosity.
2. Maxillary third molars too low in relation to the second molars.
3. Poor angulation in relation to the second molar and the tuberosity.
4. The possibility of the third molar involving the maxillary sinus.
5. Small, odd-shaped third molars, or an indication of the formation of small roots.

In the interest of obtaining the most accurate information in regard to the area under consideration, it is suggested that the usual full-mouth radiograph be supplemented by the use of an extraoral film. This film is to be devoted to the positions of the first, second, and third molars and the maxillary tuberosity areas. This gives a different and more accurate perspective to the angulation, the state of development, and the relationship of the dental units under consideration, and at the same time it gives a good picture of the occlusion. This is important, for much depends upon the information gathered. There is a great variation in the time of development of the third molars[8] and this, together with the amount of development in the tuberosity region, has a bearing on the decisions to be made in the event of a needed maxillary distal movement and a possible replacement of the second molar by the third molar. For this reason, the dental age, as evidenced by the development of the dental components, must be given as much consideration as the chronological age.

The importance of a well-shaped third molar crown cannot be stressed too heavily, if the third molar is to be used as a replacement. Great irregularity in size and shape are noted, and many times this variation is indicative of the root development that may be expected. Small crowns with narrow widths at the cervical margins do not lend themselves to development of normal-sized roots. Relief of congestion in the posterior segment should not be gained by the substitution of inadequate occlusal bearing and root support. Many third molars have odd-shaped crowns with irregular cusp formations, and, while occlusal grinding frequently is needed, there is a limit to its use and these teeth cannot be recommended.

Early interception of Class II malocclusions by headcap treatment at an age when full advantage may be taken of the possibilities of growth and development has been a great advance in orthodontic procedures. This practice, together with the proper handling of serial extractions, has obviated many of the difficulties in dealing with the adult dentition.

Graber[11] has presented a case in point. Orthodontic treatment of an extreme Class II, Division 1 malocclusion was begun when his patient was 9 years of age. A year later the maxillary second molars were extracted and ultimately replaced by the third molar. The full extent of growth possible for this patient was realized, with the result that the maxillary first molars were not displaced distally in relation to the cranial base in the final analysis. This is not always possible, for many orthodontic problems are presented when our patients are at an age when the possibilities of growth are not enough to compensate for the degree of tooth movement necessary, as in Class II cases, or to retain the full complement of teeth, as in Class I cases.

If the removal of a maxillary second molar is contemplated, it is well to have a mental picture of the course of eruption of the third molar following this extraction. This is important, for while the general pattern of third molar eruption in such cases is downward and forward, the individual patterns of behavior will vary considerably. This variance is due to the differences in angulation of the third molar in relation to the occlusal plane and to the maxillary and mandibular second molars.

During its eruption following a second molar extraction, the third molar rotates or tips mesially as it descends, the amount of rotation being directly associated with the degree of angulation. The greater the degree of angulation, the greater the amount of rotation, with the center of rotation being based on the root apex. This rotation, together with the downward and forward path of eruption, is a major factor in determining when the second molar extraction may be planned. The ideal condition calls for the descending third molar to come into contact with the maxillary first molar and into occlusion with the mandibular second molar at the same time. This presents a problem in timing, for the best results are not obtained if we are to be faced with further impaction, open contacts, or poor interproximal areas which result from lack of attention to the details of eruption.

In a Class I malocclusion, if a maxillary second molar is to be extracted, the third molar should have descended to the extent that the occlusal surface is

approximately level with the vertical midline of the second molar root and the mesial surface of the unerupted third molar is fairly in line horizontally with the distal surface of the mandibular second molar. Following extraction of the second molar, the third molar will then descend in a downward and forward arc, rotating into contact and occlusion at the same time. If the third molar is at a point much higher than the vertical center of the second molar root, there is a possibility of impaction or premature contact before occlusion is attained. This situation is reversed when the third molar is at a lower level in relation to the second molar; that is, it is likely to erupt into occlusion before contact is established with the first molar, resulting in open contacts and poor interproximal situations.

There are two salient factors which may cause a variation in the vertical placement of the maxillary third molar:

1. Variations in the angulation of the third molar to the occlusal plane.
2. The degree of distal tipping of the maxillary second molar.

These variations in angulation and position of the second and third molars are important, and the differing actions must be emphasized if full benefit is to be gained by the procedure. The following case reports will illustrate the significance of the foregoing statements and will demonstate the essential movements of the maxillary third molar under varying conditions following second molar extractions.

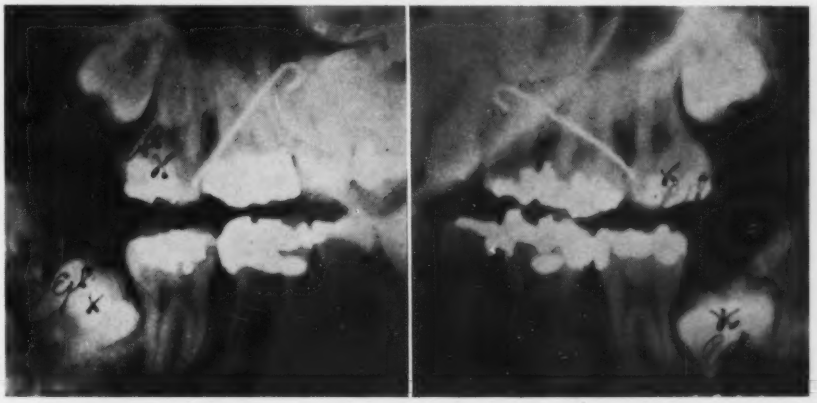


Fig. 1. Case 1. Following treatment of original Class II, Division 1 malocclusion, there was difficulty in holding occlusion. Carious second molars were extracted. Third molar angulations: right, +20 degrees; left, +26 degrees.

CASE 1. Patient D. S., aged 15 (Fig. 1), originally had a Class II, Division 1 malocclusion. Maxillary second molar extractions were planned, but these teeth were not removed until the third molars were in a position of advantage. In the meantime, the Class II movement had been completed. Some difficulty was encountered in retaining the Class II reduction, and, following removal of the second molars, a slight readjustment with headcap treatment was necessary.

Following this, the case remained stable; two years later, when the patient was 17 years of age (Fig. 2), the third molars made a normal replacement of the second molars, moving into occlusion and contact with the opposing and adjacent teeth at approximately the same time. Originally there was considerable distal tipping, or angulation, of the third molars—

+20 degrees on the right and +26 degrees on the left. The third molars were slightly lower than the vertical midpoint of the second molar roots, and horizontally they were approximately on a line with the distal surface of the mandibular second molars.

Just prior to coming into occlusion, the third molars had rotated to 0 degrees on the right and +10 degrees on the left, the angulations being based on the plane of occlusion. The third molars were of good size and shape and, upon eruption, made excellent replacements for the second molars, which were not only filled but also had buccal decalcifications.

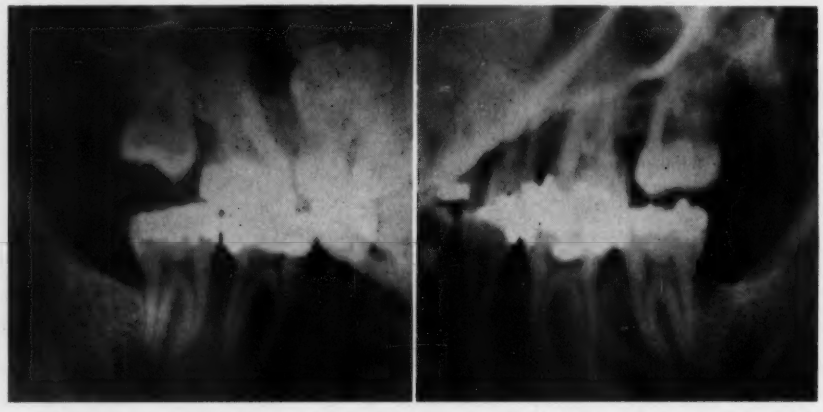


Fig. 2. Case 1. Two years following second-molar extractions, third molars are erupting. Third molar angulations: right, 0 degrees; left, +10 degrees. Occlusion has settled.

It should be noted that there was a marked change in the angulation of the third molars in relation to the occlusal plane during their eruption. This is accounted for by the rotation of the third molars during eruption, the rotation centering around the apex of the third molar. Not all third molars have this amount of angulation; since the tendency is for the erupting tooth to arrive at a more vertical angulation, this factor must be considered in judging the expected amount of downward and forward eruption, in addition to the rotation. For this reason, angulation has an important bearing on the timing and position of the teeth involved if an extraction is planned.

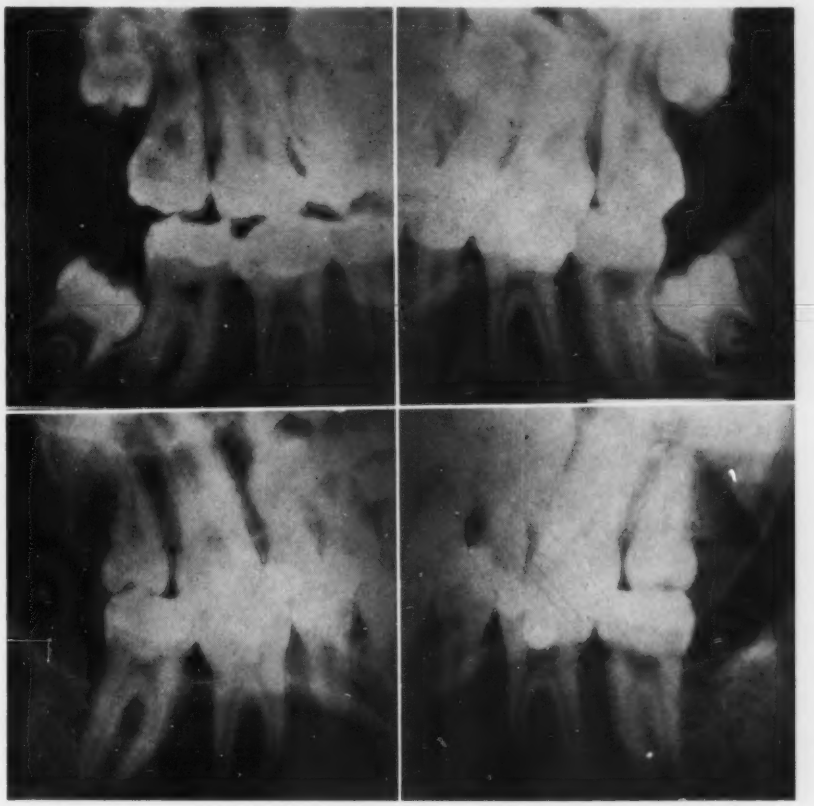
The next case illustrates a different angulation and shows the resulting change in behavior of the maxillary third molar.

CASE 2. Patient D. R., aged 17 years (Fig. 3, *A*), had a mild end-to-end Class II, Division 2 occlusion. The maxillary second molars had been filled and showed evidence of buccal decalcification. Originally, the third molars were too high on the roots of the second molars for successful use as replacements and would have contacted the first molars too soon before coming into occlusion. Following establishment of a Class I occlusion, the third molars had descended to a vertical point where their use as substitutes for the decalcified and filled second molars might be contemplated.

It will be noted that the third molar position was quite vertical, the angulation of both right and left third molars being 0 degrees in relation to the occlusal plane. In such a case more attention must be given to the amount of downward and forward eruptive movement necessary, as there usually will be comparatively little mesial rotation during this eruption if the timing is such that occlusion and contact are established at the same time. This lack of marked rotation permits the maxillary third molar to be slightly higher on the second molar root than in the case of greater angulation in which the amount of rotation must also be taken into consideration during eruption of the third molar.

The maxillary second molars were extracted in this case, and three years later, when the patient was 20 years of age (Fig. 3, *B*), the third molars were found to have erupted into good contact and occlusion, with normal interproximal bone. The downward and forward eruption had been timed to allow contact and occlusion to occur at the same time; this is important if the best results are to be obtained. There has been no rotation of the third molars during the eruptive process, as both right and left third molar angulations are still recorded at 0 degrees to the occlusal plane.

A.



B.

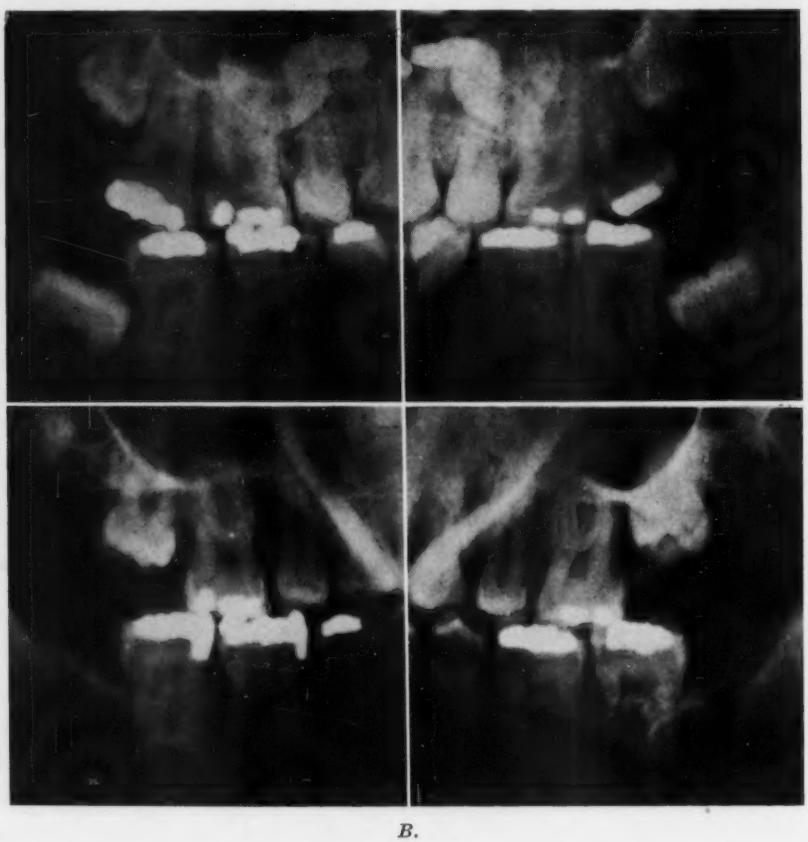
Fig. 3. Case 2. *A*, Third molar crowns in correct vertical and horizontal relation to maxillary and mandibular second molars. Third molar angulations: right, 0 degrees; left, 0 degrees. *B*, Three years following extraction of maxillary second molars. Third molar angulations: right, 0 degrees; left, 0 degrees.

CASE 3. Patient D. G., aged 16 years (Fig. 4, *A*), originally had a Class II, Division 1 occlusion. There was considerable angulation of both the second and third molars, the third molar angulations being +20 degrees on the right and +30 degrees on the left. As the distal tipping of the second molar increased, the third molar, which was adjacent to the root of the second molar, moved forward and changed its horizontal relationship with the mandibular second molar. In this situation the third molar should be at a slightly lower level in relation to the root of the maxillary second molar prior to second molar extraction. This allows the third molar to assume a better relationship with the distal surface of the mandibular second molar and prevents premature contact with the first molar too far in advance of coming

into occlusion. In a case such as this, because of the marked angulation of the third molars, careful consideration should also be given the amount of rotation which will be obtained in addition to the downward and forward eruptive movement.

One year following extraction of the second molar (Fig. 4, *B*) the third molars had rotated considerably, the angulations now being +4 degrees on the right and +12 degrees on the left. This follows the tenet that the greater the original angulation, the more rotation may be expected during the descent of the third molar.

A.



B.

Fig. 4. Case 3. *A,* Change in vertical and horizontal relationship of molars. Third molar angulations: right, +20 degrees; left, +30 degrees. *B,* One year following second molar extraction, maxillary right third molar will contact first molar prematurely. Third molar angulations: right, +4 degrees; left, +12 degrees.

The case just presented also demonstrates the importance of the horizontal relation of the maxillary third molar to the mandibular second molar prior to any maxillary second molar extraction. It will be noted that horizontally the right third molar was mesial to the distal surface of the mandibular second molar; as a result of the rotation plus the downward and forward path of eruption, premature contact with the first molar will occur. Eruption of the left third molar was uneventful, but the premature contact made the right third molar eruption difficult; this could have been prevented if the right third molar had been permitted to descend further and to assume a more favorable relation with the mandibular second molar.

The three cases just described demonstrate the essential variations to be found in the angulation of the maxillary third molars, in their relationship to both the maxillary and mandibular second molars, and in the behavior of the third molars following extraction of the second molar.

In Class II malocclusion, in contrast to Class I, the crown of the maxillary third molar is horizontally advanced in relation to the mandibular second molar. This change in horizontal relation calls for a re-evaluation of the vertical position of the third molar in the event extraction of the maxillary second molar is contemplated at the start of or during treatment. In Class II cases in which the second molar is to be extracted at the time the distal movement is started, it has been found that the most ideal location of the third molar is approximately at the junction of the crown and root of the second molar. Most of the reduction in space is accounted for by the distal movement of the maxillary first molar; in this event, the third molar does not have to move forward any appreciable distance, and the downward eruptive movement is the main essential. Barring precocious development and eruption of the teeth, there are not many cases in which this early extraction of the maxillary second molar may be used in Class II reductions. As Shapiro[12] has pointed out, this procedure should be used only "when the molar relationship is end-on." There are many cases, however, in which maxillary second molar extraction will be of extreme benefit during the course of the Class II reduction or after it is finished; the timing of the extraction depends upon the relationship of the third molar to the root of the maxillary second molar and the amount of forward and downward movement needed to bring the third molar into function. The amount of such movement that is necessary will depend, to a great extent, on the relationship of the maxillary and mandibular first molars at the time the decision is made.

The angulation of the maxillary third molars to the plane of occlusion and their relation to the tuberosity must be carefully considered at times, for they have a vital effect on the results obtained. The usuable angulation will range from 0 to +30 degrees (distal tip), the angulation being based on the occlusal plane and the long axis of the third molar. The greater the angle, the more attention must be given the tuberosity and its relation to the crown of the third molar. The closer the occlusal surface of the third molar approaches a 90 degree angle with the posterior wall of the tuberosity, the less opportunity there is for a favorable eruption; this is due to the fact that there is less opportunity for the third molar to descend and rotate freely without interference from the tuberosity or the buccal plate. The opposite angulation (the minus side) should be avoided if possible, for many of these relations will result in unsatisfactory interproximal areas and future periodontal pockets following eruption.

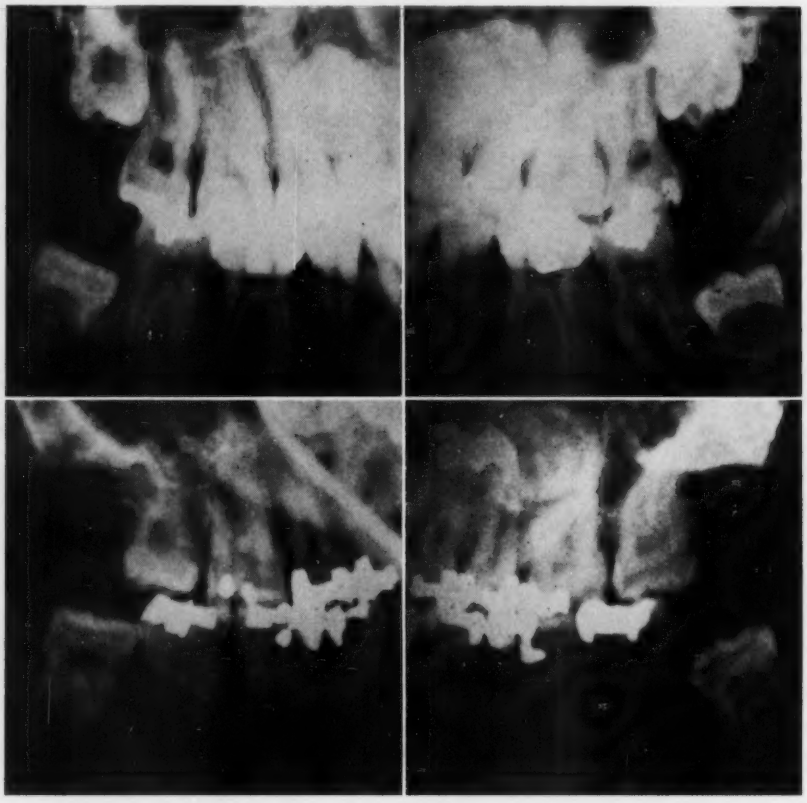
INDICATIONS AND CONTRAINDICATIONS

At this point some additional cases will be presented to support the use of maxillary third molars as replacements for the second molars where indicated. Some illustrative cases in which this practice is contraindicated will also be presented. There are practical limitations to all theories, and it is well that

these limitations be considered in the over-all treatment planning with respect to future stability and well-being. The following case reports will illustrate some of the points previously enumerated.

CASE 4. Patient P. W., 15 years of age, originally had a Class II, Division 1 malocclusion, with the maxillary left posterior teeth in buccoversion; this patient responded to routine treatment with the results seen in Fig. 5, *A*. Difficulty was encountered in retaining the occlusion in the right posterior region. Oral examination showed that the maxillary second molars had been filled and that considerable buccal decalcification had begun. Radiographic examination revealed that the maxillary third molars were of good size, with indications of normal roots, and in good relation with the maxillary and mandibular second molars. The

A.



B.

Fig. 5. Case 4. *A*, Difficult retention on right. Second molars filled. Third molar angulations: right, +4 degrees; left, 0 degrees. *B*, Three years after extraction of second molars, contact and occlusion are good. Third molar angulations: right, 0 degrees; left, 0 degrees.

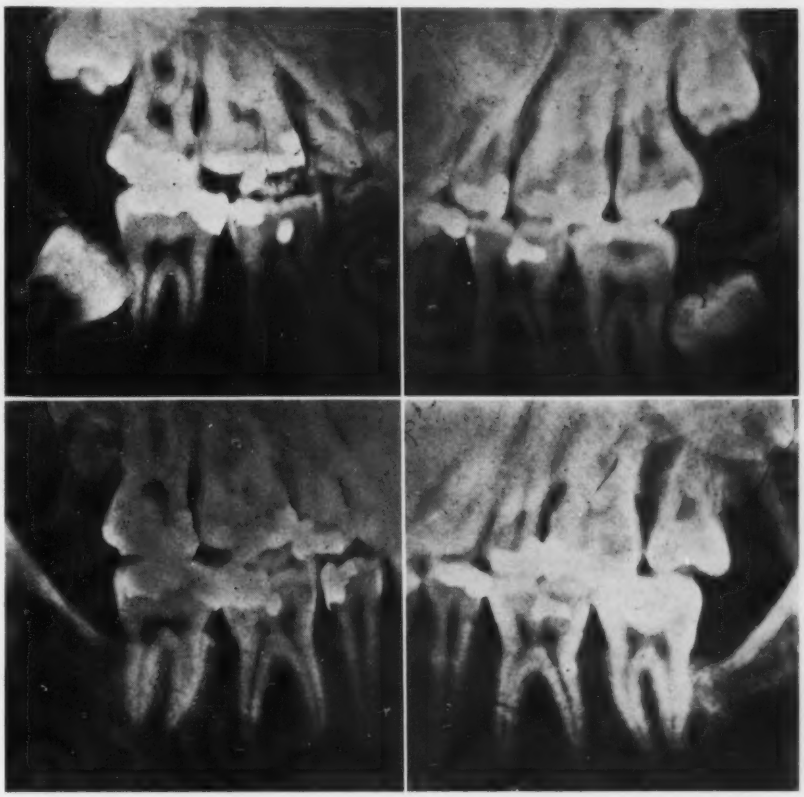
occlusal surfaces indicated that some occlusal grinding might be needed. The third molar angulation was 0 degrees on the left and +4 degrees on the right, both within the range of usability. It was decided that, to aid in the problem of retention and to replace the second molars which showed signs of future carious involvement, the maxillary right and left second molars should be extracted.

Three years following this decision (Fig. 5, *B*) the results were as anticipated. The occlusion had remained stable, the interproximal bone was in good condition, the decalcified

and filled second molars had been replaced, and the maxillary third molars were in good relation to the approximating and opposing teeth. The angulation of both right and left third molars was now 0 degrees.

CASE 5. Patient P. H., aged 16 years, originally had a Class II, Division 1, Subdivision occlusion. This case (Fig. 6, *A*) demonstrates the plausibility of the proposed treatment plan, particularly as regards the replacement of filled and carious teeth with sound tooth structures. It was anticipated at the start of treatment that the maxillary second molars might need to be extracted, but at that time the third molars were too high in the tuberosity and in relation to the second molars. No difficulty was encountered during the Class II reduction. At the end of treatment, radiographs revealed that the maxillary third molars were in an almost ideal position to replace the filled and carious second molars. The third molar angulation

A.



B.

Fig. 6. Case 5. *A*, Maxillary second molars decayed. Third molars in good position. Third molar angulations: right, +12 degrees; left, +10 degrees. *B*, Three years after extraction of right second molar, the filled left second molar remains. Angulation of right third molar is 0 degrees.

was +12 degrees on the right and +10 degrees on the left. The third molars were vertically and horizontally in fair relationship to the maxillary first molars and the mandibular second molars.

The patient's father and the family dentist apparently questioned the diagnosis and decided that one third molar and one second molar should be extracted in the interest of experimentation. Three years later (Fig. 6, *B*) there was a good replacement of the maxillary

right second molar with a sound third molar which had an angulation of 0 degrees. The maxillary left third molar was extracted instead of the second molar, and a second molar with large restorations and a doubtful future remains as a result.

CASE 6. Patient M. H., 19 years of age, originally had a Class I bimaxillary malocclusion; following treatment (Fig. 7, *A*), no problems were encountered in retention of the posterior segments. Four premolars had been extracted during the course of treatment. The maxillary second molars had large mesial and buccal alloy restorations, and it was thought that replacement of these teeth with the maxillary third molars would improve the dental condition. The maxillary right third molar had a favorable angle of +10 degrees, was in good vertical

A.

B.

Fig. 7. Case 6. *A*, Left third molar tipped into tuberosity and buccal cortical plate. Third molar angulations: right, +10 degrees; left, +30 degrees. *B*, One year later, left second molar extraction is contraindicated but right second molar is to be extracted. Angulation of third molars remains the same.

relation to the second molar, and horizontally was well related to the distal surface of the mandibular second molar. Indications were that it would make a justifiable replacement of the second molar.

The maxillary left third molar presented a different set of factors. It was tipped distally and buccally into the tuberosity at an angle of +30 degrees. It was also posterior to the distal surface of the mandibular second molar. All of these factors contraindicated a successful pattern of behavior for the left third molar.

One year later (Fig. 7, *B*) the maxillary right third molar had descended slightly, while the left third molar showed no evidence of favorable movement and the angulations

remained the same. The angulation of the third molar, the position in the tuberosity, the unfavorable relation to the mandibular second molar, and the fact that no improvement in position had been exhibited in a year reaffirmed the contraindications established previously. Removal of the left third molar was advised. The maxillary right second molar will be removed, although, because of the slight change in vertical position, the third molar is not quite so favorably placed as it was one year earlier.

CASE 7. Patient M. F. originally had a Class II, Division 1 malocclusion at the age of 13 years. No complications were encountered during the Class II reduction, but the patient was somewhat indifferent to oral hygiene and dental care during treatment and subsequent

A.

B.

Fig. 8. Case 7. Left third molar too far distally and right third molar too low vertically. Third molar angulations: right, +22 degrees; left, +27 degrees. *B*, Two years after extraction. Note open contacts and poor interproximal bone. Third molar angulations: right, −10 degrees; left, −10 degrees.

retention. By the time (Fig. 8, *A*) the patient was 16 years of age, the dental future of the maxillary second molars was questionable because of deep alloy restorations and decalcification. This raised the question of practicality. Would the third molars satisfactorily replace the second molars if the latter were removed?

The importance attached to the vertical and horizontal relationship which should exist between the maxillary second and third molars and the mandibular second molars is clearly illustrated in this case.

The angle of the third molars to the plane of occlusion was favorable—+22 degrees on the right and +27 degrees on the left. The occlusion was now Class I, rather than Class II, and the maxillary third molar should occupy a vertical position approximately at the midline of the second molar roots. Horizontally, the mesial surface of the third molar should be on the same plane as the distal surface of the mandibular second molar. In contrast to these conditions, the maxillary left third molar was posterior to the distal surface of the mandibular second molar, and the maxillary right second molar had descended to a point nearing the ideal for extraction of the second molar in a Class II reduction, rather than in the Class I reduction which was now needed.

The patient at this point was 16 years of age. Because of the desire to replace the extensively filled and decalcified second molars with sound tooth structures, the maxillary second molars were extracted. The result (Fig. 8, *B*) was an unsatisfactory replacement by

A.

B.

Fig. 9. Case 8. *A*, Third molars are involved with maxillary sinus and thus are poor risks for distal movement. First premolars were extracted. *B*, Three years later, there is no evidence of third molar movement. Extraction of maxillary second molars is contraindicated.

the third molars two years following extractions. The angulation had shifted to −10 degrees, both right and left, during rotation into position. Both maxillary third molars came into occlusion with the mandibular second molars before contact was established with the maxillary first molars; this resulted in open contacts and a poor interproximal condition of the bony process. The radical change from a favorable plus angulation to an adverse negative angulation was caused by the continuing rotation of the third molars in an attempt to establish contact with the first molar.

While the precepts laid down regarding angulation, vertical and horizontal positioning, and the need for establishing normal contact and occlusion may be slightly elastic in certain cases, they cannot be disregarded to the extent exhibited in the foregoing case with any hope of good results. Extraction of maxillary second molars is contraindicated in situations of this kind.

CASE 8. Patient C. P., 17 years of age (Fig. 9, *A*), had a Class II, Division 2 malocclusion with a very restricted maxillary tuberosity area. An abortive attempt at distal movement of the maxillary molars was very soon abandoned and the second and third molar areas were subjected to closer scrutiny. Strang,[13] in a discussion of compromise treatment, reports treating this type of case by extracting the maxillary second molars, correcting the Class II malocclusion, and allowing the maxillary third molars to assume the position of the extracted second molars. His alternative treatment was to extract the maxillary first premolars and leave the case in a Class II relation.

A.

B.

Fig. 10. Case 9. *A*, Mandibular first molar was lost one year earlier, when patient was 11 years old. Class II, Division 1 malocclusion, with teeth drifting. Poor occlusion. *B*, Four years later, occlusion has been re-established and third molar will serve as good substitute.

In the present case the maxillary tuberosity area was so restricted than when the patients was 17 years of age the maxillary second molars had not entirely erupted and the third molars were very high and had a questionable relationship with the maxillary sinus. Third molar angulation was +5 degrees on the right and +10 degrees on the left. The maxillary first premolars were accordingly extracted as a compromise treatment because of the involvement of the third molars with the maxillary sinus.

Three years later (Fig. 9, *B*) a complete release of the maxillary second molars was evident, and there was a Class II occlusion. The third molars now showed a distinct involvement with the posterior portion of the maxillary sinus and evidenced no apparent shift from the original position. Anticipated use of maxillary third molars that have any apparent connection with the maxillary sinus is contraindicated, for if the third molar shifts at all it will seldom shift far enough to be of use following a second molar extraction.

CASE 9. Patient Y. K., aged 12 years (Fig. 10, *A*) had a Class II, Division 1 malocclusion, complicated by the loss of the right mandibular first molar. The majority of cases in which third molars may be used successfully involve the maxilla, but sometimes the interpretation of rules must be broadened in an attempt to correct serious situations. In a malocclusion of any classification the loss of mandibular molars is a crippling blow which adds lack

of vertical support and a shifting occlusion to an already present malocclusion. In this case the mandibular right first molar had been lost when the patient was 11 years of age, and mesial tipping and rotation of the second molar had taken place, accompanied by the typical loss of contact and distal and lingual tipping of the mandibular premolars. With reduction of the Class II relationship, movement of the mandibular second molar into the first molar

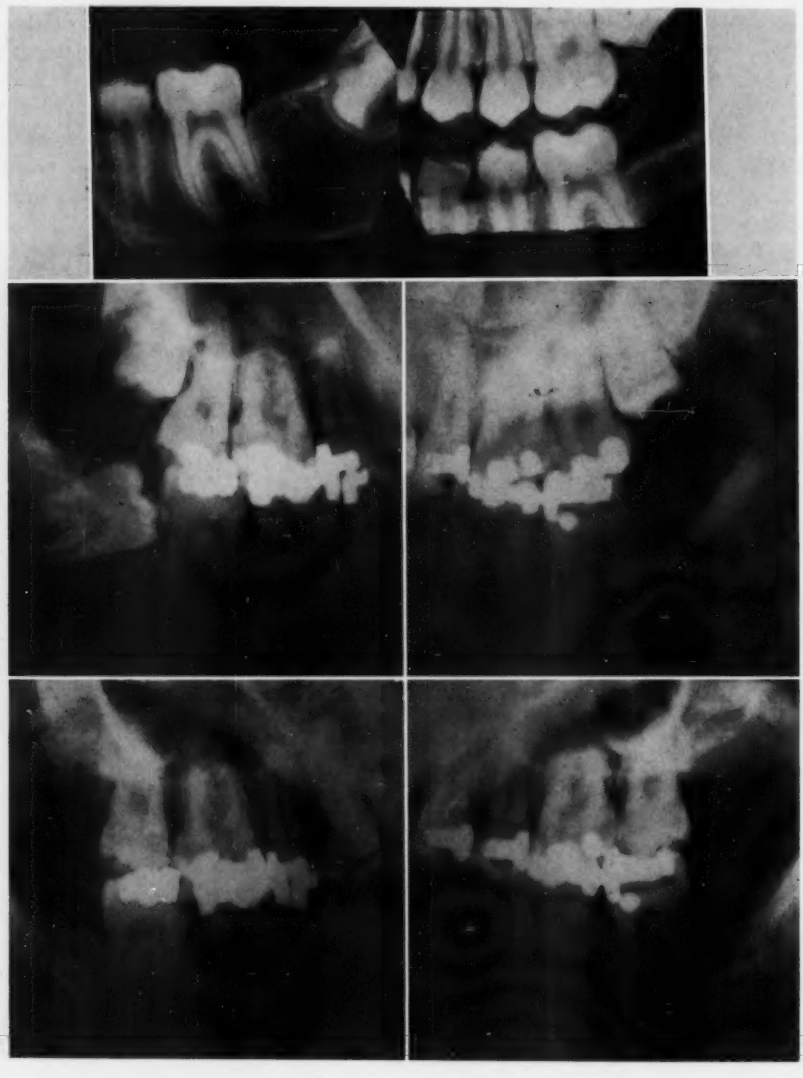


Fig. 11. Case 10. *A*, Patient K. H. at 13 years of age. Mandibular right second molar was extracted one year earlier. *B*, at 19 years of age. Mandibular right third molar has been functioning as a second molar for approximately three years. Maxillary second molars will be removed. Maxillary third molar angulations: right, +22 degrees; left, +25 degrees. *C*, at 20 years of age. Maxillary right and left third molars and mandibular right third molar have replaced second molars.

position, and uprighting of the third molar, a suitable and stable occlusion was obtained (Fig. 10, *B*). Four years later the mandibular third molar was in a position where it was serving well, even though the roots were not as large as might be desired. The occlusion was stable, and the full dentition was functioning. It is felt that the result was well worth the

extra time and effort, when viewed from the standpoint of mouth health and the later loss of maxillary second molars which might have occurred because of lack of occlusion and function if the mandibular third molars had not been utilized.

CASE 10. Patient K. H., 13 years of age (Fig. 11, *A*), had an incipient Class II malocclusion. The mandibular right second molar had been extracted for some obscure reason approximately one year earlier. This case also presented the problem of future lack of function in the second molar area, with possible future loss of the maxillary right second molar because of elongation and lack of occlusion. Class II headcap treatment corrected the existing mild malocclusion, and approximately two years later the mandibular third molar was available for the appliance therapy needed to move it into functional position.

When the patient was 19 years of age, approximately three years following this correction (Fig. 11, *B*), the occlusion remained stable and the mandibular third molar was serving well as a substitute for the lost second molar. The maxillary second molars at this time were filled, and there was evidence of additional decalcification. The third molars were in good position to replace the second molars, being well placed vertically and horizontally, with a favorable angulation of +22 degrees on the right and +25 degrees on the left. One year following extraction of the maxillary second molars (Fig. 11, *C*) the third molars were in good occlusion, with well-formed roots and good interproximal bone. Third molar angula-

A.

B.

Fig. 12. Case 11. *A*, All second molars have been extracted because of large restorations. Maxillary third molar angulations: right, +2 degrees; left, −20 degrees. Mandibular third molar angulations: right, −35 degrees; left, −50 degrees. *B*, Four years later, third molars have replaced second molars. Maxillary third molar angulations: right, −7 degrees; left, −2 degrees. Mandibular third-molar angulations: right, −20 degrees; left, −36 degrees.

tion was +2 degrees on the right and +5 degrees on the left. While the total observation time covered a period of several years, comparatively little time was spent in active treatment. As a result, the dentition is in good condition and the occlusion is stable.

Extraction of mandibular second molars with the expectation of replacing them with the third molars is not recommended as a routine practice. The mandibular third molars are usually on adverse negative angles and, because of the occlusal and mesial distance over which they must move before coming into contact, they do not erupt into the most favorable occlusion and leave much to be desired with respect to the interproximal areas. However, there are some instances in which, because of carious involvement and consideration of the future posterior occlusion, extraction of the mandibular second molars will be of value.

CASE 11. In the case of Patient N. S., aged 17 years (Fig. 12, *A*), the future of the second molars was endangered by deep restorations and decalcification. In response to the dentist's plea, the possible removal of all second molars was considered, and consent was given on the premise that readjustment would be possible following eruption of the third molars. The maxillary third molars were not in the most favorable angle, the right being +2 degrees and the left −20 degrees. The maxillary right third molar was vertically somewhat low on the root of the second molar, especially in view of the small degree of angulation present and the slim chance of actual rotation into position. The maxillary left third molar, being on a minus angulation, ordinarily would not erupt favorably because of the tendency of these teeth to move into a vertical position as they are released from the tuberosity, thus reducing the amount of mesial migration ordinarily seen during eruption into occlusion.

In this case it was well that the mesial surface of the maxillary left third molar was anterior to the distal surface of the mandibular second molar, thereby reducing the amount of forward movement necessary before the third molar could come into contact and occlusion.

All second molars were extracted. As shown four years later, the final positioning of the maxillary and mandibular third molars (Fig. 12, *B*) was serviceable, but it would have been more acceptable if the opportunity had been presented, as planned, to correct the angulation of the mandibular third molars orthodontically. The maxillary left third molar erupted into a favorable position with an angle of −2 degrees. This was due to the fact that the tooth did not need to move forward the full distance ordinarily needed in a Class I occlusion before it came into contact with the first molar, and contact in all cases is of primary importance. It is interesting to note that a change of 18 degrees, from −20 degrees, in angulation was made in an attempt to establish a vertical position in contact and occlusion.

Extractions of this kind cannot be routinely advised, but there are cases, especially if continuous observation is possible, in which a distinct service may be rendered by such a procedure. Possibly, it would have been more advantageous to make this move at an earlier date; later, however, as the third molars erupted further, the same procedure would have been untenable.

CASE 12. Patient J. J., aged 17 years (Fig. 13, *A*), had a Class I malocclusion and a maxillary right supernumerary molar that needed to be removed. Both right and left third molars were present. Their angulations were +8 degrees on the right and −17 degrees on the left.

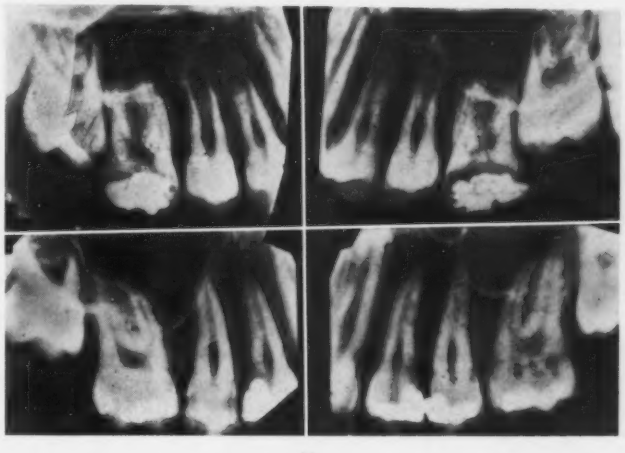
On the right, the question of removing the third molar at the same time as the supernumerary tooth arose. Because of the danger of denuding the root of the maxillary second molar during removal of the supernumerary tooth and the third molar, it was decided that the second molar and the supernumerary tooth should be extracted and that the third molar should be allowed to erupt. The third molar was on an angle of +8 degrees, its mesial surface

A.

B.

Fig. 13. Case 12. Right second molar and supernumerary tooth removed. Maxillary left third molar extracted. Third molar angulations: right, +8 degrees; left, −17 degrees. *B*, Three years later. Maxillary left third molar would have served better than retained carious second molar. Right third molar angulation: 2 degrees.

A.



B.

Fig. 14. Case 13. *A*, Hypoplastic and decayed maxillary first molars to be removed. *B*, Two and one-half years later, maxillary second molars have replaced first molars. Third molars will follow. Note open contacts, increased caries, and drifting of premolars.

was anterior to the distal surface of the mandibular second molar, and it was located rather high on the second molar root. Such forward positioning and vertical height are not ordinarily favorable, since the third molar in its forward migration is likely to reach contact with the maxillary first molar too soon prior to coming into occlusion. At times this leaves an unsatisfactory interproximal area.

Three years later (Fig. 13, *B*) the maxillary right molar was at an angle of +2 degrees, and it did contact the first molar approximately six months before settling into occlusion. While the change in angulation was only 6 degrees, the amount of downward and forward movement from this height was sufficient to permit premature contact, which resulted in a deficient interproximal area. However, the feeling is that this is more desirable and will give better service than a second molar whose root has been denuded.

The maxillary left third molar was removed. In view of the future caries problem, however, it would have been better to extract the second molar and to allow the third molar to erupt. Although the third molar was on a –17 degree angulation, it was well anterior to the distal surface of the mandibular second molar and would have followed the usual tendency to approach a movement that was more vertical than mesial, and the third molar should have reached occlusion and contact satisfactorily. The result at this time, however, is that the second molar remains, handicapped with a large restoration and buccal decalcification.

CASE 13. Patient B. B., aged 12 years (Fig. 14), had a problem with which we are all familiar. In general, however, too little attention is paid to the ultimate results in such cases until it is too late. The problem concerns loss of the first molars—in this particular instance the maxillary first molars.

Cases of this type are pointedly described by Salzmann[14]; of special interest are his references to shifting occlusion and an increased incidence of carious lesions, particularly following loss of the maxillary first molars.

In the case at hand the patient had a Class I malocclusion with almost an end-to-end relationship. The first molars were hypoplastic; they had been filled and now had considerable recurrent decay and an uncertain future. Second molar eruption was slightly delayed, and there was evidence of the presence of third molars. Since the unerupted second and third molars would have a tendency to move downward and forward, and the premolars would tend to move distally under the circumstances, it was felt that the extraction of the maxillary first molars would be a safe procedure at this time. Delay in extracting the first molars would allow the second molars to erupt to the point where occlusion would prevent their moving forward into proper contact and all advantage of the extraction would be lost.

The premolars did shift distally, and the second and third molars erupted downward and forward to the point where contact and occlusion were established two and one-half years later. However, the loss of contact in the premolar area resulted in the predictable increase in carious activity, and loss of molar support during eruption permitted a marked closure of the bite.

In the light of present-day knowledge, it is advised that when such procedures are authorized the orthodontist assume full control and take steps to check such unfavorable results as overshifting of posterior segments, the tendency of the premolars to rotate and move lingually, the production of open contacts with resulting carious lesions, and closure of the bite. It is possible to provide a replacement for handicapped maxillary first molars, and with proper responsibility it is possible also to maintain the rest of the desirable points.

SUMMARY

The theme of this article has been the replacement of the second molars by the third molars, when and if such replacement is needed. The needs revolve around stabilization of the denture, release of crowded arch conditions, replace-

ment of teeth handicapped by carious lesions and large restorations, and removal of some of the load on anchorage units. Factors governing the conditions under which these replacements may be made were described, and it was pointed out that a review of the conditions should be made.

The specific area of interest has been the maxillary tuberosity and the room available for eruption of the second and third molars. Lack of room in this area results in impaction or buccal eruption of many third molars and, at times, of the second molars. In Class II malocclusions, distal movement of buccal segments is inhibited or made more difficult by this restriction, and an additional burden is placed on anchorage units. Both Class I and Class II malocclusions may be affected, but the most frequent complications in the tuberosity are encountered as a result of Class II reductions during or subsequent to treatment. At times release of the restriction may be obtained by extraction of the maxillary second molar and its replacement by the third molar if conditions are favorable; otherwise, the third molar may be removed.

If removal of maxillary second molars is contemplated, the third molars to be used as replacements must be examined closely for size, shape, and possibility of good root development. Third molars with small or irregular-shaped crowns and small roots make poor substitutes for most second molars.

Maxillary second molars that are decayed or have large restorations which limit their future usefulness are subject to replacement, provided suitable third molars are present. The third molar to be used must be in favorable relation to the tuberosity and to the maxillary and mandibular second molars, and it must not be involved with the posterior wall of the maxillary sinus as described by Salzmann.[14] Normally the maxillary third molars erupt in a downward and posterior direction, but often the angulation is reversed and the long axis is downward and anterior. This calls for a different set of values if use of the third molar is contemplated. Emphasis has been placed on the angulation and position of the third molar and the effect which these angulations may have on the path of eruption and behavior following a second molar extraction. Consideration of these factors is important if good contact, occlusion, and interproximal areas are to result.

The maxillary third molar has proved to be a suitable substitute for the second molar when used as indicated. However, indications and contraindications must be carefully evaluated prior to any program of removing the second molar and making use of the third molar. For this reason, as much emphasis has been placed on contraindications as on indications. An attempt has also been made to bring to call attention to the fact that *mandibular* second and third molars may also be of some value as substitutes for lost members.

CONCLUSIONS

The purpose of this discussion is not to point to the maxillary tuberosity area as the main source of orthodontic troubles but, rather to point out some of the problems emanating from this area which affect treatment and treatment results. The procedures described are usually used in patients 14 to 17 years of age, for in this age bracket all teeth but the third molars are ordinarily erupted.

While growth may still be expected in this group, it is questionable in some cases whether enough will be gained to obviate the need for extractions. When there are carious lesions in the maxillary second molars, the procedure has proved very satisfactory and the third molars have proved to be fitting substitutes for the extracted teeth. Retention problems in Class II nonextraction cases have been simplified, and the occlusion has settled in a satisfactory manner following second molar extraction where such treatment was indicated.

The conditions governing the procedure allow some leeway in certain cases. In general, however, the rules should be followed rather closely, for failure to do this may handicap, rather than help, the patient dentally in future years. The theory of extraction as an aid in orthodontic treatment is well established, but there must always be a well-founded reason for the extraction of any teeth, whether it be premolars or second molars. It is also well, when contemplating the use of a third molar, to ascertain whether one is present before proceeding with the extraction.

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Uses and limitations of electromyography in the quantitative study of skeletal muscle function

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ELECTRICAL changes accompany normal muscular activity. These electrical changes may be picked up by electrodes placed on the skin or embedded in the muscle, amplified, and recorded photographically or mechanically. Because of the ease with which the electrical changes may be recorded, it is desirable to relate them, as far as possible, to other fundamental neuromuscular processes. In the present article no attempt will be made to cover the field of clinical electromyography; nor will studies dealing with the time, duration, or phasic action of muscles be considered. For an excellent introduction to the whole subject of electromyography the reader is referred to the summary by Buchthal,[1] and for examples of the uses of electromyography in analysis of complex phasic activities of muscles reference may be made to the University of California studies on human locomotion[2] and to the studies by Moyers,[3] Carlsöö,[4] and Hickey and colleagues[5] on the muscles of mastication. Attention here will be confined to those attempts which have been made to correlate quantitatively the electromyogram with such mechanical functions of muscle as tension and work performed.

In the discussion that follows, it will be necessary to use the term "integrated" as opposed to "direct" electromyography. The wave form of directly recorded electrical potentials of muscle is ordinarily quite complex. It is inaccurate simply to compare peak-to-peak amplitudes, and it is difficult to make any other comparisons. For this reason, planimetric,[6, 7] rectified-filtered,[8] and electronically integrated[9, 10] methods have been used in descriptions of the electrical activity of muscle. In the present article these methods of electromyography will be designated as "integrated."

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PARALLELISM BETWEEN TENSION AND EMG IN A MUSCLE AT FIXED LENGTH

Bayer and Flechtenmacher[11] appear to have been the first to describe clearly the parallelism between tension and amplitude of the electromyogram in a muscle voluntarily contracted at a fixed length (isometric contraction). Inman and co-workers[8] and Lippold[6] made similar observations. Fig. 1 shows the close correspondence between the integrated electromyogram and tension, under isometric conditions, in the biceps brachii of an amputee who had undergone kineplasty (the muscle was freed at the distal end and attached to a dynamometer) and in the tibialis anterior of a normal subject. Fig. 2 shows that a

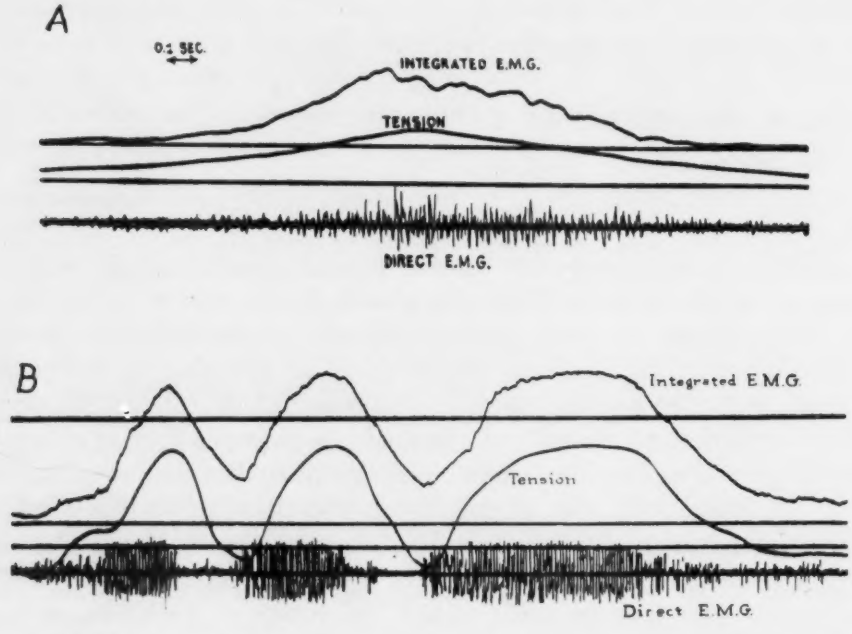

Fig. 1. *A*, Integrated electromyogram, isometric tension, and direct electromyogram with varying degrees of effort of biceps brachii of amputee with kineplastic tunnel. Note parallelism between integrated electromyogram and tension. *B*, Integrated electromyogram, isometric tension, and direct electromyogram of tibialis anterior of normal subject. Force measured was produced by dorsiflexion of foot with muscle length kept constant. (From Inman and Others: *Electroencephalog. & Clin. Neurophysiol.* 4: 187, 1952.)

similar correspondence between electromyogram and tension exists in the normal biceps brachii under isometric conditions, regardless of the type of recording electrodes used. Fig. 3 shows the linear relationship between the integrated electromyogram and tension in the same muscle in two experiments performed at different times. It should be noted that, although these experiments yielded similar results, the two lines do not exactly coincide. It is not possible to reproduce precisely the results of such an experiment, once the electrodes have been removed from the subject and other conditions of the experiment have been altered. Angelone and co-workers[7] noted this in their recent article dealing with the relationship between bite force and electrical activity of the masseter muscle.

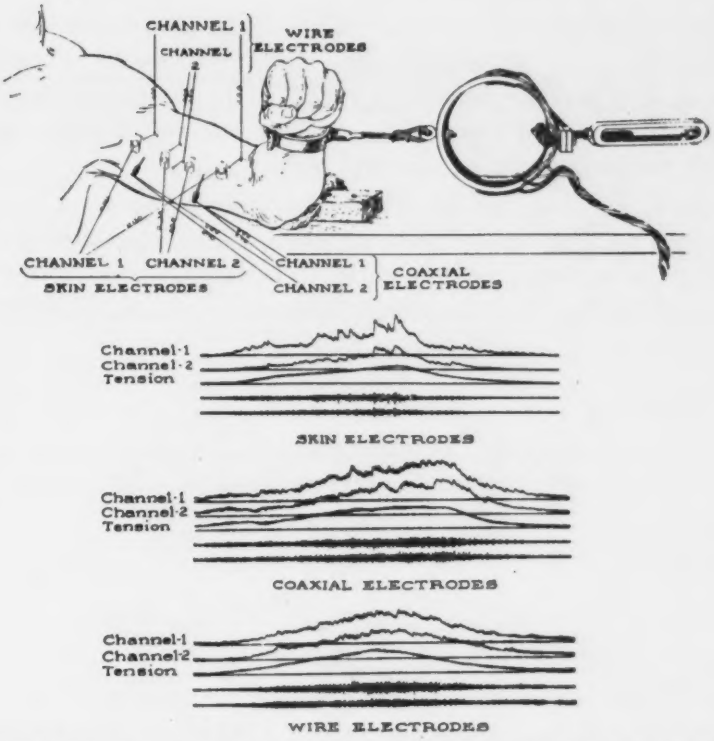

Fig. 2. Effect of different types of recording electrodes on integrated electromyogram. Parallelism between tension and integrated electromyogram is demonstrated equally well with all electrodes and various placements. (From Inman and Others: *Electroencephalog. & Clin. Neurophysiol.* 4: 187, 1952.)

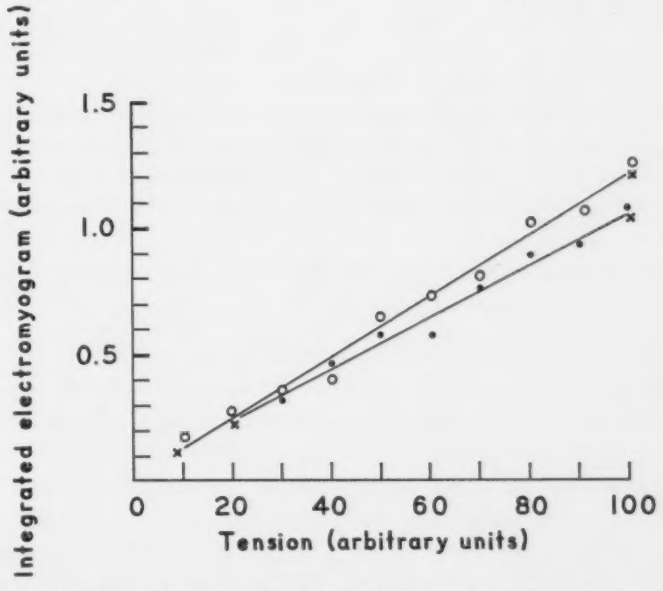

Fig. 3. Linear relationship between integrated electromyogram and isometric tension in human calf muscles; two experiments on same muscle, separated by long interval of time. (From Lippold: *J. Physiol.* 117: 492, 1952.)

Fig. 4 (curve *B*) shows the linear relationship between the integrated electromyogram and tension in the triceps brachii in experiments in which a constant load was held for different periods of time. Here the proportionality between total electrical output and time, with constant tension, depends on a constant relationship between electromyogram and tension.

These studies all show that the integrated electromyogram may be used as an index of tension in a muscle voluntarily contracted under isometric conditions, provided that the conditions of the experiment remain constant in regard both to the placement of the recording electrodes and to the physiologic state of the muscle.

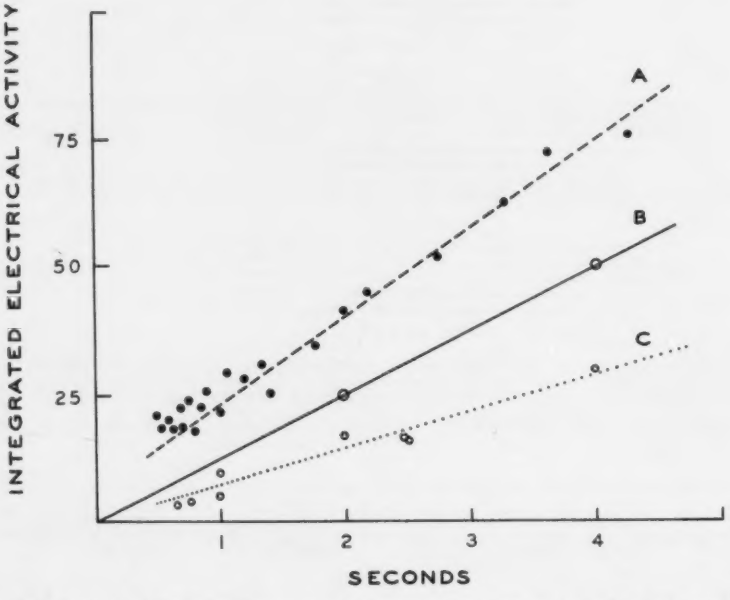

Fig. 4. Integrated electromyogram (arbitrary units) as a function of duration of contraction of triceps brachii in two subjects. *A*, Elevation of 6 kg. weight (dynamic active work); *B*, maintenance of 6 kg. weight (static "work"); *C*, replacement of 6 kg. weight (dynamic resisting work). (From Scherrer, Bourguignon, and Marty: *J. Physiol., Paris* **49**: 376, 1957.)

LACK OF PARALLELISM BETWEEN TENSION AND ELECTROMYOGRAM IN A MUSCLE ALLOWED TO CHANGE DRASTICALLY IN LENGTH

Fig. 5 shows the integrated electromyogram and tension in the triceps brachii of an amputee with a kineplastic tunnel. In the top tracing the muscle is at a short length, and with maximum effort the integrated electromyogram is of high amplitude. In the lower tracing the same muscle is stretched, and with maximum effort the integrated electromyogram is of low amplitude. It can be seen that no correlation exists between the amplitude of the electromyogram and the tension, although the subject is making a maximum effort in both cases. It is well known that the muscle spindles and the Golgi tendon organs play an important role in determining the degree of excitability of motor neurons in the spinal cord. Libet and co-workers[12] have made a study of autogenetic

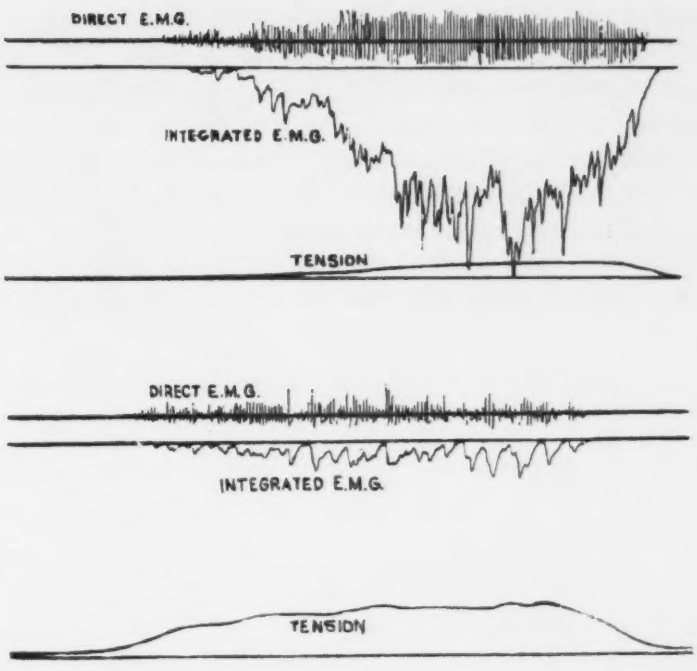

Fig. 5. Direct electromyogram, tension, and integrated electromyogram of right triceps of amputee with kineplastic tunnel. *Above,* Muscle very short; *below,* muscle stretched; maximum effort in both cases. Note fall in electromyogram in stretched muscle. (From Inman and Others: *Electroencephalog. & Clin. Neurophysiol.* 4: 187, 1952.)

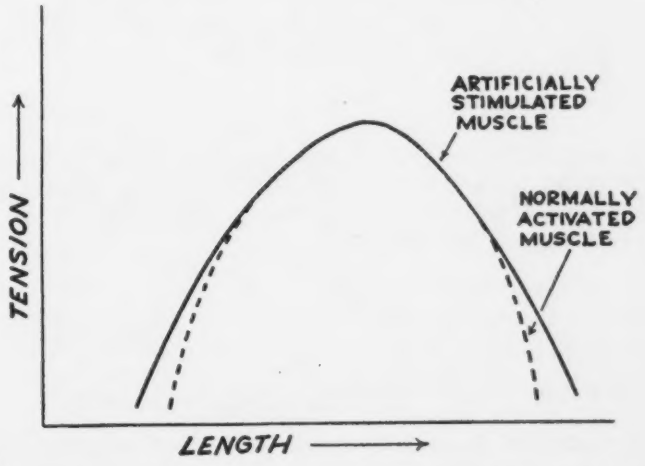

Fig. 6. Curve of developed tension in isometric length-tension diagram. Solid line represents muscle stimulated with maximum tetanic stimulus; broken line represents muscle normally stimulated in intact body. Because of lack of spindle facilitation at short lengths and Golgi end organ inhibition at long lengths, normal curve falls below experimental curve at the extremes. (From Ralston: *Am. J. Phys. Med.* 36: 94, 1957.)

inhibition in certain large muscles of the human lower extremity and have shown the importance of tendon afferents in modifying the electromyogram of muscles under stretch. There can be little doubt that the changes in the electromyogram shown in Fig. 5 are due to afferent effects arising from end organs within the muscle or tendon. Fig. 6 illustrates in a qualitative way the difference between the curve of developed tension in a muscle normally activated in the body and one maximally stimulated by external electrical means.[13] In the body, the motor neurons may not be sufficiently excitable when the muscle is at extremes of length to be completely accessible to stimulation from the cerebral cortex. Consequently, no clear relationship exists between electromyogram and tension when the muscle is allowed to change greatly in length.

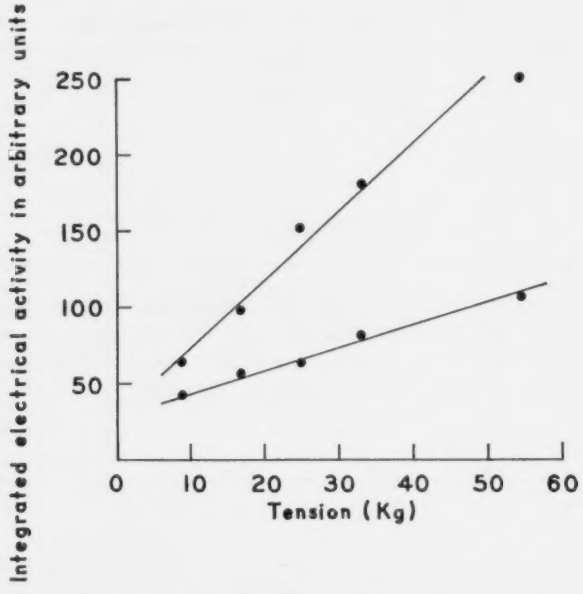

Fig. 7. Relationship between integrated electromyogram and tension in human calf muscles. *Above,* Shortening at constant velocity; *below,* lengthening at same constant velocity. Tension represents weight lifted. Each point is mean of first ten observations on one subject. (From Bigland and Lippold: *J. Physiol.* 123: 214, 1954.)

It may be that such pronounced spindle and/or tendon effects do not occur in small muscles to the same degree as in large muscles. This is a field of study that needs much more exploration.

RELATIONSHIP BETWEEN FORCE, VELOCITY, AND THE ELECTROMYOGRAM UNDER CERTAIN RESTRICTED CONDITIONS

Fig. 7 shows the relationship between the integrated electromyogram and tension in human calf muscles when the muscles are shortening at constant velocity (upper curve) and lengthening at the same constant velocity (lower curve). In these experiments the range of movement allowed at the ankle was restricted to 6 degrees above and below the midposition of the joint.

In each case, there is a linear relationship between the integrated electromyogram and tension, but the slopes of the lines are quite different for the shortening and lengthening muscles. In other words, the integrated electromyogram could not be used as in index of tension unless the precise conditions of the experiment were specified.

Fig. 8 shows the relationship between the integrated electromyogram and the velocity of shortening (above) and lengthening (below) when the muscles are at the same tension. It is striking that in the case of lengthening the integrated electromyogram is practically independent of the velocity. Here, again, it is clear that the relationship between electromyogram and tension depends on the conditions of the experiment.

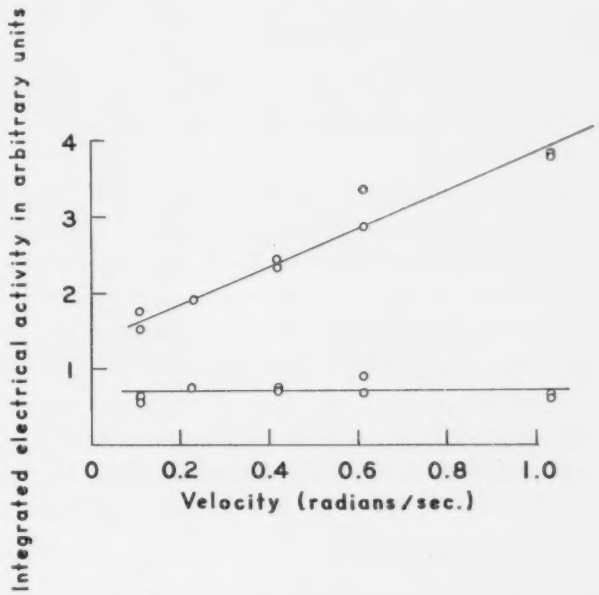

Fig. 8. Relationship between integrated electromyogram and velocity of shortening (*above*) and lengthening (*below*) at same tension. Each point is mean of first ten observations on one subject. (From Bigland and Lippold: *J. Physiol.* 123: 214, 1954.)

ISOMETRIC EFFORT, ISOTONIC WORK, AND THE ELECTROMYOGRAM

Scherrer and co-workers[10] argue that the various findings described thus far in the present article make likely a linear relationship between the quantity of integrable electrical activity during the active phase of a movement and the external mechanical work effected. Thus, Fig. 4, curve *A*, represents the electrical "cost" of lifting a load of 6 kg. through a certain distance in a given interval of time, and curve *C* refers to a restraining movement—that is, the muscle is acting against the motion of the load. The electrical output of a muscle is a function of the number of active muscle fibers and the rate of firing of each fiber. Consequently, these authors state, the curves of Fig. 4 may be used to compare the extent of muscular "work" in static and dynamic effort.

The straight lines of Fig. 4 speak for themselves. However, great caution must be exercised in quantitatively relating electrical activity to metabolic energy expenditure. The action potential associated with a single muscle twitch is not materially affected by a change in the length of the muscle, while the amount of heat produced is. There is no simple relationship, therefore, between electrical output and metabolic expenditure.

The lower curves of Figs. 4, 7, and 8 agree in showing an electromyogram of lower amplitude in a muscle during lengthening than during shortening. Oxygen consumption is known to behave in similar fashion. These observations suggest that fewer muscle fibers and/or a lower rate of firing need be used during lengthening than during shortening to achieve the same force of contraction.

MUSCLE POWER AND THE ELECTROMYOGRAM

The term "power" is used loosely in many articles dealing with muscle physiology. It is used here in its strict sense: the rate of doing work, or the rate of expenditure of energy.

It was shown by Inman and co-workers[8] that, in large muscles working over great changes in length, no simple relationship exists between electromyogram and tension. However, the curves of Figs. 7 and 8, dealing with restricted excursions of muscle, may be interpreted as showing a linear relationship between power and tension and between power and velocity, provided the conditions of the experiment are specified exactly. This follows from the definition, power = force $\times$ velocity.

It must be noted that findings in such experiments refer to the work done *on the load* and *not* to the energy expenditure of the muscle. The latter could be determined only if the efficiency of the muscle were known, and this information is not ordinarily obtainable.

FATIGUE AND THE ELECTROMYOGRAM

Lippold and co-workers[14] give an illuminating review of the effects of fatigue on the electromyogram. Edwards and Lippold[15] have shown that the relationship between the electromyogram and isometric tension changes during fatigue. Although it remains linear, the slope of the line increases, which suggests that more muscle fibers are being brought into play. Scherrer and Bourguignon[16] state that the total electrical activity per second during an initial maximum isometric contraction may be considerably less than in the same muscle after a period of hard work. As a matter of fact, the electromyogram and the isometric tension change in opposite directions. The most likely explanation for this is synchronization of motor-unit activity, which results in higher electromyogram amplitude. Such synchronization is known to occur during fatiguing work.

In view of these findings, investigators seeking quantitative relationships between the electromyogram and muscle performance must avoid the possibility of fatigue complicating the results.

DISCUSSION

An attempt has been made to describe the present status of electromyography with regard to evaluation of the mechanical performance of muscle. It is evident that the integrated electromyogram can be related to isometric tension in a quantitative way but that certain precautions must be taken to avoid complicating factors. Changing the conditions of the experiment, as by removing and replacing the recording electrodes, may entirely invalidate the results, as may the occurrence of fatigue.

There are even more complicating factors to consider in electromyographic studies of dynamic performance. Under highly restricted conditions of excursion, load, and speed of muscle contraction, quantitative relationships with the electromyogram may be shown. Such conditions are almost unobtainable in ordinary clinical practice. They would be particularly difficult to obtain in studies on the muscles of mastication and other muscles important in dentistry. Nearly all the studies dealing with quantitative aspects of electromyography have been done on large muscles of the extremities, which are readily accessible and relatively easy to work on.

Therefore, I take a rather pessimistic view of the potentialities of quantitative electromyographic studies in the field of dental research.

SUMMARY

Studies of the electrical activity of human skeletal muscle provide much valuable information with respect to the time, duration, and phasic relationships of muscle contraction, as well as for the diagnosis and prognosis of neuromuscular disease. However, the measurement of such mechanical functions as force, speed, and work from electromyographic data is possible only under certain restricted conditions.

In such studies, the "integrated" electromyogram has been found to be useful.

In view of many difficulties of both technique and interpretation in relating the electromyogram to mechanical function, it is considered that such quantitative studies will not prove to be of extensive applicability in the case of muscles of importance in dentistry.

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Prognathism questions in the surgical-orthodontic team

MARSH ROBINSON, D.D.S., M.D., F.A.C.S.,* and
HARRY L. DOUGHERTY, D.D.S., M.A.**
Los Angeles, Calif.

BECAUSE of recent advances in surgical technique,[1] more patients are now being considered for surgical correction of prognathic mandibles. Ten years ago such operations were considered only for patients wth grossly deformed jaws, whereas today many minor deformities are receiving the attention of the surgical-orthodontic team.

In spite of the fact that the orthodontic problems involved are usually less difficult than those he works with every day, the orthodontist is usually at a loss as to how to proceed with his first "teamwork case." By answering the following questions, we will try to show how the surgical-orthodontic team can function in the best interest of the patient.

WHEN SHOULD THE PATIENT BE REFERRED?

It is a rare case that can be corrected by surgical intervention alone. The orthodontist should never refer a patient *out* of his office but should call *in* a surgical consultant. Surgical consultation should be requested when the growth pattern shows a mandibular prognathism that cannot be functionally and esthetically corrected by orthodontic treatment alone. Before consultation a complete orthodontic evaluation, which includes models, photographs, and cephalometric films, should be made. The surgeon needs recent study models. It is a good idea to request surgical consultation for the young patient, even

Presented at the annual meeting of the American Association of Orthodontists, Denver, Colorado, April 20, 1961.

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though he may not need surgical correction. The parents and the patient are always pleased when the growth pattern is such that only orthodontic treatment is required. The parents are unhappy if, after several years, they are told that surgical treatment is indicated. If the situation is presented in lay terms, the parents can understand that mandibular growth is not predictable. If the surgical-orthodontic team is functioning during this watchful, waiting stage, many problems which complicate the successful outcome of surgical and orthodontic treatment can be circumvented. The extraction of mandibular premolars should be avoided if the patient needs later surgical correction, because such extraction creates a postsurgical discrepancy in dental arch sizes. Unnecessary expansion of the maxillary arch and root resorption of the maxillary anterior teeth as a result of heroic orthodontic treatment can also be avoided by early evaluation by the team.

WHEN SHOULD THE PATIENT HAVE SURGICAL TREATMENT?

There is no ideal age for surgical correction. Successful operations have been performed on patients from 10 to 60 years of age. The surgical-orthodontic team should not base its schedule on the rare person whose jaw grows to age 24. In girls, the mandible usually ceases to grow two years past initial menstruation; at the age of 16 or 17 boys have most of their mandibular growth. Repeated cephalometric records are of value in determining the answer to this question. Occasionally younger patients, because of poor social adjustment or severe malfunction, should receive surgical correction. In these cases the parents must understand that a second operation at a later time may be necessary. In the cases of younger patients in whom extreme prognathism has been corrected, both parents and patients have been more than willing to accept this possibility.

WHEN SHOULD THE PATIENT HAVE ORTHODONTIC TREATMENT?

Generally it is better for the surgeon to complete his work before orthodontic treatment is started. The postsurgical mandibular position is not accurate within 1 mm., and it is possible that presurgical tooth movement will have to be reversed to correct this inaccuracy. It is better if the patient's teeth are not mobile during fixation, and the surgeon can work more efficiently with no fear of displacing the orthodontic appliance. The problem of intermaxillary fixation in the postsurgical healing period should not be considered by the orthodontist, for the surgeon can place arch bars in approximately one half hour. In some patients only one arch needs to be banded. The space taken by these bands must be carefully considered in the postoperative position. This is a complex and complicated factor. Preoperative orthodontic treatment should be accomplished when the study models indicate that cross-bite will result after surgery. This can be determined by placing the study models in the postoperative position. In these cases a "cut-off" should be made and the teeth waxed in the expanded or contracted position to occlude with the opposing jaw in the postoperative position. The "cut-off" wax model is the guide to presurgical orthodontic treatment. The orthodontist takes no heed of the relationship between maxilla and mandible. He regulates the teeth to the "wax-up"

position, so that at the time of surgical intervention the mandible can be placed in the desired position. The lower anterior teeth in many patients with mandibular prognathism are in linguoversion, and in some the upper anterior teeth are in labioversion. The patient appears progressively more prognathic as the teeth are uprighted over the base bone. If this is necessary, the patient and parents must definitely understand that as the preoperative orthodontic treatment progresses the patient's appearance and occlusion will become worse. If the orthodontic appliance is to be used by the surgeon for intermaxillary fixation, all anterior teeth must be banded. The heaviest possible passive arch wire should be placed at least one month before operation without adjustments. There can be no tooth movement after the surgeon takes impressions for the acrylic intraoral splint.

WHAT SHOULD BE THE MANDIBULAR POSTOPERATIVE POSITION?

For the surgeon, a correction of 20 mm. is no more difficult than a correction of 4 mm. It is the tendency of the orthodontist to scheme and to "lean over backward" to make the surgeon's job easy. Occasionally it may be that overcorrecting into a Class II relationship can make the orthodontic postoperative problem easier. There have been cases of Class III double protrusion in which the mandible should be placed in a Class II relationship, followed by extraction of maxillary premolars. The orthodontist should insist on the surgically feasible position which will make his work as easy as possible.

SUMMARY

Answers have been given to the four questions concerning treatment of mandibular prognathism by the surgical-orthodontic team:

1. When should the patient be referred for surgical consultation?
2. When should the patient have surgical treatment?
3. When should the patient have orthodontic treatment?
4. What should be the postoperative position of the mandible?

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Specialties in the American Dental Association

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I THOUGHT it might be worth while today to tell you something of current developments concerning specialty practice in the dental profession. As you know, the American Dental Association, spearheaded by its Council on Dental Education, has give this matter a great deal of study. The way in which the profession meets the issue will most certainly have significant bearing on its ability to serve the public in the years ahead.

Before I discuss the present status of the problem, however, let me place the matter in context by reviewing what has already taken place.

As of late 1951, the American Dental Association recognized seven specialty groups and had approved the requirements of their examining boards. The seven groups, of course, were oral surgery, orthodontics, pedodontics, periodontics, prosthodontics, oral pathology, and dental public health. Since 1951, no other specialty groups have been recognized, although several have applied for specialty recognition.

It was three years later, in 1954, that the Council on Dental Education first announced a moratorium on the consideration of applications from other groups seeking specialty recognition. The moratorium was imposed to allow time for further study and appraisal of the entire problem of dental specialties and specialty boards. There was good reason for further study, since by this time six additional groups had applied for recognition. Approval of all six applications would have given the profession a total of thirteen specialties. Obviously, dentistry need to take a careful look at the situation.

The moratorium was continued throughout 1955 and 1956, although on numerous occasions the Council reminded the profession that it in no way sought to discourage advanced study in any area of dentistry.

Read before a joint meeting of the Southern California Society of Dentistry for Children and the Southern Component of the Pacific Coast Society of Orthodontists, Los Angeles, California, April 24, 1961.

*President-Elect of the American Dental Association.

During this time, the Council asked the seven existing specialty boards to develop lists of the specific clinical skills which they expected their diplomates to possess in order to utilize the knowledge received in the advanced curriculum. With the same end in view—to clarify the additional areas, if any, that were susceptible to specialization—definitions of the terms "graduate" and "postgraduate" as applied to training programs were established.

In its report to the 1956 House of Delegates, the Council submitted the following statement which clearly reveals the trend of thought up to that time:

> The Council believes that the division of the practice of dentistry into specialties depends upon a logical separation of dental services into categories characterized by fundamentally different objectives and distinct biological and physical approaches to diagnosis and treatment, involving knowledge and skills beyond those which can normally be expected for the general practice of dentistry—rather than a fragmentation of dentistry based upon technics or procedures.

The Council went on to announce that all specialty boards should begin giving consideration to accepting only formal education as an entrance criterion and suggested that preceptorship training should then be accepted only in unusual or exceptional cases.

Since it was felt that the general philosophy embodied in the statement which I have just quoted was satisfactory for use by the Council in approval of requirements for examining boards in the dental specialties, the moratorium was lifted in 1957.

At the same time, the Council encouraged the establishment of study groups, societies, and academies for the extension of knowledge and experience in areas of dental practice not yet recognized as specialties by the Association. It also encouraged dental schools, whenever feasible, to provide opportunities for advance study in all areas of dental practice.

The importance of encouraging such practices is reflected in a resolution adopted by the House of Delegates in 1957, which stated that formal recognition of a dental specialty was in part dependent upon demonstration of the "fact that there are a substantial number of acceptable educational institutions which offer graduate and postgraduate courses of at least one year of study which are directly related to this area." A survey by the Council indicated that there were 207 graduate programs in thirty areas of the dental curriculum. During the same period, 100 postgraduate programs were offered in seventeen areas of the dental curriculum. As expected, however, there was considerable variation in course offerings from area to area.

The 1958 House of Delegates, like its predecessors, was called upon to deal with ramifications of the issue. In this case the Board of Trustees stated, in a report to the House, that "the current problem of the recognition of one specialty group and its integration under an existing board (the reference is to the American Board of Prosthodontics) was merely the forerunner of many similar problems to follow. . . ." The Board went on to express concern that the existing pattern of specialty boards already approved by the Council and the Association might not permit ready solution of specialty problems which would inevitably arise.

Consequently, the Board took three actions:

First, it requested the 1958 House to reimpose the moratorium until the 1959 annual session, which the House agreed to do.

Second, the Board directed the Council to present to the Board, at its March, 1959, meeting, a restatement of the requirements for the approval of specialty boards in dentistry, a restatement of the present grouping of specialties and of potential specialty groups, and a proposal to broaden the base of the specialty boards in their election procedure.

Third, the Board directed the Council to make a complete survey of the approved specialty boards, particularly with regard to the government and administration of the boards' prerequisites for examination, and requirements for certification of diplomates.

Throughout this period, the Council was increasingly aware of the lack of any definitive, long-range program for the development of specialties in dentistry. Specialty growth had come about by unplanned evolution rather than systematic development.

In its continuing effort to develop such a long-range program, the Council, in its 1959 report, presented a series of issues which required detailed clarification before consistent programs could be established. These issues, were stated as follows:

1. Definition of the basic concepts which would dictate and govern the establishment of specialties.
2. Recognition of specialists and specialties by the action of state legislatures.
3. Recognition of the ADA's responsibility for definition of dental specialties and specialists through bylaw provision.
4. Provisions in the *Principles of Ethics* which would define responsibilities of the dental specialist.
5. Definition of present and future relations between the Association and existing or potential specialty groups.
6. Criteria for the Association's recognition of national certifying boards.
7. Definition of the areas of dental practice under which the Council could conduct programs for recognition of national certifying boards.

Part of the House's total response to this list was to amend the bylaws so as to empower the Council to study and make recommendations concerning recognition of special areas of dental practice, approval or disapproval of national certifying boards, educational and administrative standards of the certifying boards, and Association action in maintaining effective liaison with the certifying boards and related special groups.

The 1959 House of Delegates took two further actions. They extended the moratorium until the 1960 annual session, and they approved a Council-drawn *Statement of Policy in Special Areas of Dental Practice, Certifying Boards,*

Diplomates, and Specialists in Dentistry. This statement reiterated the desirability of eliminating the preceptorship type of training and set Jan. 1, 1967, as the terminal date for acceptance of such training under the program of the American Association of Orthodontists.

Two conferences held during 1960 brought together various interested groups and thus helped clarify the issues to an even greater degree.

As a result of these conferences, additional consultations, and independent work, the Council brought three resolutions to Los Angeles last October for consideration by the House of Delegates.

One resolution provided that after Jan. 1, 1965, "all members who announce themselves to the public as specialists or as limiting their practice in one of the areas approved by the American Dental Association be required to hold a certificate from a national certifying board approved by the Association or a state license permitting announcement in one of the areas approved" by the Association. The 1960 House postponed action on this resolution until the 1961 session in Philadelphia. The primary objection seemed to be that the resolution, as drawn, would prohibit announcement of specialization by a potential board diplomate in the interval between conclusion of formal graduate-level education and board certification. Since that time, the Council has been in the process of developing alternate plans for establishing definite requirements for announcement of specialization that would overcome these objections.

Under the terms of one alternate plan currently being given serious consideration by the Council, a dentist who wished to specialize would be required to undertake an additional period of advanced education after receiving his dental degree. The number of years of such advanced study would be stipulated for each area of specialization. At the conclusion of this advanced education, he could announce himself as a specialist, provided, of course, that he limited his practice to the recognized area. However, if he should wish to do so, he could then go further to meet the requirements of the certifying board in his area, pass its examination, and become a diplomate. Having become a diplomate, he could naturally continue as a specialist as long as he fulfilled all necessary requirements, such as limitation of practice. The unique aspect of this proposal is the provision for a minimum educational requirement before specialty announcement is permitted. This is in keeping with the belief that anyone who calls himself a specialist should satisfy certain minimum standards of education and experience beyond what is provided by the undergraduate dental curriculum.

The 1960 House of Delegates also lifted the moratorium on the number of specialties.

This has been, I must admit, a hasty and generalized review of the developments in this field. It reminds me of a professor of history I once heard about. Students going into his class were warned of the extreme speed with which he covered lengthy and complicated periods of history. The truth of the warning was shown one day when one of the students dropped his pencil. He bent down and picked it up and, leaning over to a classmate, asked if he had missed anything. "The Civil War," was the answer he received.

I hope, however, that from this welter of facts, a few constant principles have stood out, principles which must be adhered to.

The first of them is that whatever decisions are taken in this area must be made with the public good as the primary consideration. The dental profession, like all professions, exisits to render an essential service to the public. To the degree that we serve the public fully and efficiently, we are meeting our responsibilities. The wishes of the profession itself, or of any segment thereof, must invariably take second place.

Second, there is no intention upon the part of the American Dental Association or its Council on Dental Education to choose some particular number—be it 7 or 17 or 77—and say that is how many specialties will be allowed. In its 1958 report, the Council stated its philosophy this way:

> The dental profession should not be over-segmented, but this philosophy does not arbitrarily place a specific limit on the number of dental specialty areas. Every effort will be made to give recognition to those areas of dental practice which meet realistic definition and requirements. . . . The scope of any specialty should be sufficiently broad to include the various elements of special competence which are encompassed by that specialty area.

The Council re-enunciated this belief in 1960 when it submitted to the House the following resolution:

> *Resolved*, that the number of areas of dental practice be limited to the minimum number which will assure the public of the competence of the dentist who holds himself out to the public as a specialist and who performs services of an unusual or difficult nature which require intensive study and extended clinical and laboratory experience beyond the accepted undergraduate training of the dentist.

The House approved the resolution, and I think that all of us can do so as well.

It is probably fair to say that there is going to be no sudden or final solution to this question of specialization. As what I have said indicates, this is a complicated area; dentistry must proceed cautiously and prudently. If, however, all of us keep continually before us our essential goal—to serve and protect the public and to strengthen and further the profession—I have no doubt that a satisfactory solution will eventually be reached. Perhaps we are closer to it at this moment than we realize.

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President's Banquet

XENOS, the Greek word for stranger, is also the word for friend. Westerners and travelers from afar, basking in the atmosphere of friendship and majestic scenery, paid tribute to a vital and effective force in the specialty of orthodontics when Dr. and Mrs. William Roy Humphrey were honored by members of Dr. Humphrey's profession at the annual dinner-dance held in the grand ballroom of the Denver Hilton.

Dr. Humphrey, as guest of honor, replied to the toast to guests and to Dr. George Anderson's presentation of the past-president's key in the enthusiastic manner that pervaded the entire fifty-seventh annual meeting of the A. A. O.

L. J. Williams.

Golden Anniversary Luncheon

THE ninth Golden Anniversary Luncheon was held in the Junior Ballroom of the Denver Hilton Hotel on April 17, 1961. The following members of the Golden Anniversary Group attended the luncheon:

Charles R. Baker
Hugh T. Berkey
Max E. Ernst
William E. Flesher
Henry F. Hoffman
Andrew F. Jackson
John R. McCoy
Oren A. Oliver
H. C. Pollock
William E. Stoft
R. H. W. Strang
W. Frank Wilson

The Golden Anniversary Group now consists of fifty-three members, of whom thirty-one are still in the active practice of orthodontics. Three new members, who began their practices in 1911, were added to the group this year:

Albert C. Holzman, Boston, Massachusetts
Joseph E. Johnson, Louisville, Kentucky
John Rush McCoy, Los Angeles, California

Drs. Holzman and Johnson were unable to be present at the luncheon, but Dr. McCoy was there and received his fifty-year lapel button in person.

Vice-President Cecil G. Muller presided over this year's luncheon. During his opening remarks, he introduced Ernest N. Bach, who proposed and helped to organize the Golden Anniversary Group in 1953. Charles R. Baker, chairman of the Golden Anniversary Committee, spoke for the entire group when he thanked the officers and members of the American Association of Orthodontists for the gracious spirit in which they have recognized and honored these pioneers in orthodontics.

This year's Golden Anniversary Luncheon was in special honor of a highly respected member, Henry F. Hoffman, who graduated in 1898, practiced orthodontics in the Colorado cities of Denver and Boulder, and retired only a short time ago. Dr. Hoffman, a close friend and contemporary of the late Albert H. Ketcham, was active throughout his career in dental and orthodontic affairs and held many important offices in the professional societies to which he belonged.

Dr. and Mrs. Henry F. Hoffman, who were honored at the ninth annual Golden Anniversary Luncheon in Denver, Colorado, April 17, 1961.

He was chairman of the committee that produced the splendid book entitled *A History of Dentistry in Colorado, 1859-1959.** Lantern slides showing the summer cottages of Drs. Hoffman and Ketcham, as well as slides of some of our members before and after the 1929 session in Estes Park, were presented.

Dr. Baker introduced a Northwestern University Dental School classmate, Charles F. Brown, who practiced in Denver until his recent retirement. Dr. Brown was described as a valuable member of his local and state dental societies.

*Douglas, William A.: A History of Dentistry in Colorado, 1859-1959, published in 1959 by the Johnson Publishing Company, Boulder, Colorado.

Dr. Baker then announced that two members had died since the last meeting —Bernhard W. Weinberger on May 9, 1960, and Charles R. Jackson on Nov. 11, 1960. Heads were bowed in a moment of silent, respectful memory.

At this point, Dr. Muller again took the floor to introduce the guest speaker, Stanley M. Garn, of the Fels Research Institute in Antioch, Ohio. Dr. Garn's address on "Research and Malocclusion" will be published later.

It was announced that Oliver W. White was unable to attend the luncheon because of the critical illness of Mrs. White.

Golden Anniversary Group, American Association of Orthodontists, Denver, Colorado, April 17, 1961. *Top row:* O. A. Oliver, M. E. Ernst, W. E. Flesher, W. F. Wilson, W. E. Stoft, H. T. Berkey, C. R. Baker. *Bottom row:* J. R. McCoy, A. F. Jackson, H. F. Hoffman, H. C. Pollock, R. H. W. Strang.

Cordial notes of friendship from Jacob A. Gorman of New Orleans and Walter H. Ellis, who was vacationing in Florida, were read. The following messages from other absent members were also read:

E. Sheldon Friel of Dublin, Ireland, wrote:

It was one of my greatest pleasures to attend the luncheon last year and to meet old friends and the people who had done so much for orthodontics. Though I cannot be there in the flesh, I shall certainly be there in spirit and I send you all my best wishes.

William T. Chapman wrote from Athens, Greece:

We are on the Swedish-American ship *Gripsholm,* taking a Greek Islands–Mediterranean–Black Sea cruise. Will land in New York on April 29. My very best wishes to you and all of the fifty-year group.

A nice telegram was received from Joseph D. Eby:

In commemoration of the rush to the Rockies Centennial, it is most befitting that the Golden Anniversary Luncheon should be celebrated in Denver today. Lest we forget the fundamental contributions of Albert H. Ketcham, Henry F. Hoffman, Frederick McKay, and others who have placed this great commonwealth within the highest echelons of the genuine progress of orthodontics in America, my thoughts and spirits will mingle among these rugged pioneers who, with their hallowed predecessors, so soundly laid the foundations as their heritage and upon which the future in both science and service may eventually plateau. With best wishes to everybody, especially Henry F. Hoffman.

Finally, this wonderful letter from one of our members who, though unable to attend our meetings, is genuinely young in heart and spirit and whose messages are encouraging and inspiring to all of us:

My dear old Pals:

I am confident that I have thought more about you and your well-being during the last fiscal year than in any other similar period. The cause doubtless is that you and I stand in need of a little more attention today than in other days. There is no better tonic for an Old-Timer than the consciousness that he is rich in the fellowship of friends.

The above high-sounding words do not exemplify the type of thinking which has been aimed at you. It has been, and is, of a practical nature. It might be that you are charged with "oldster delinquency." From all quarters come reports of "juvenile delinquency," and we have come to think that such wrong-doing consists solely of destruction of property, such as breaking out the window panes at the schoolhouse and scattering ashes on the principal's desk. No such indictment stands against us, but let's see if we are without guilt. Delinquency means "failing in duty or offending by neglect." Are we guilty of an offense against ourselves by failing to provide employment, both physical and mental, in our retired days?

Get yourself a hobby. Many hobbies today await our choosing, and each, in its own way, fills the idle hours with wholesome profit, entertainment, and enjoyment. A dentist makes a living with the use of tools (instruments), and it is only natural that when he quits Main Street he will still feel the urge to continue to use some of them. What he needs is a shop, a retreat, a place he can call his own where he can make a noise, gather together his tools and gadgets, and find entertainment of his own creation. The "do-it-yourself" movement is rapidly coming to the fore, and the amateur will find ready assistance on all sides to help him with his project. A "do-it-yourself" library, consisting of twelve volumes, is just now off the press. These books are written for the amateur and are replete with descriptions of tools and materials for his use. You may charge that I am trying to make cabinetmakers out of you boys. Not so. That is my hobby, and it keeps me from spending a dull moment. The choice of a hobby for you is an individual problem. What I am urging you to do is to choose one now, if you have not already done so; get into it wholeheartedly and make it part of your life. It will surely bring you comfort and happiness.

Being able to surrender the office keys which you have carried so long and so honorably and to go home and occupy your favorite chair which has afforded you rest and comfort after many a toilsome day, with no thought of the obligation to meet that 8:30 appointment tomorrow, seems a glorious achievement and experience. And so it is. But the change is too great and the transition too incompatible with a career just ended. The latent energies still within us cry out for recognition and employment. Will we heed the call and thereby become the beneficiaries of an inheritance which is rightly ours?

I hope that you will permit me to terminate this preachment with the following words, said in sincerity:

Friends such as you don't grow older—just dearer.

Most cordially yours,
Ernest W. (Pat) Patton.

Meeting of the American Board of Orthodontics

THE American Board of Orthodontics held its annual six-day meeting April 10 through April 15, 1961, for the purpose of conducting routine business and examining candidates for certification.

The unanimous choice for the new director to be appointed to the Board was Richard M. Railsback of Piedmont, California. Dr. Railsback replaces Wendell

The American Board of Orthodontics. *Top row:* Frank P. Bowyer, Nathan G. Gaston, Paul V. Reid, Alton W. Moore. *Bottom row:* B. F. Dewel, Wendell L. Wylie, J. A. Salzmann.

L. Wylie, whose seven-year term of office expired at the time of the Denver meeting and who served as president of the Board during his final year of service and as secretary the year before.

In the final session the Board adopted by acclamation the following tribute to Dr. Wylie:

As your term on the American Board of Orthodontics draws to a close, we your fellow directors take this opportunity to tell you that we consider the years that we served on the Board with you a truly rewarding experience. When we think of your many outstanding contributions to the Board we are primarily impressed with the total objectivity which you showed in examining and grading applicants for certification. This quality, so important to your own outstanding research and educational activities, has left a lasting impression and has added greatly to the continuing effectiveness of the Board.

The American Board of Orthodontics has been extremely fortunate to have had you serve as its secretary. Through your constant devotion to its affairs and the many significant improvements which you introduced in the examination and grading of applicants, the quality of the examinations has reached a new and higher level. Your services have enhanced the high esteem which we feel the Board enjoys in orthodontics and in dentistry as a whole.

We wish you success in all your future undertakings. We are confident that you will adhere to the dictum "Once a Director, always a Director" and that the Board will continue to benefit from your wise counsel in the years to come.

Certification was granted to twenty-eight candidates as follows:

Theodore Adler
Lawrence G. Alexander
Hubert J. Bell, Jr.
Wayne A. Bolton
Melvin R. Briskin
John J. Byrne
Hugh Carpol
Lloyd L. Cottingham
Robert D. DeButts
Robert S. Freeman
Arnold M. Geiger
David J. Gross
Francis M. Hapak
Ernest Herman
Herbert Hoffman
Joseph R. Jarabak
George S. Kendrick
Seymour Levin
Sydney L. Meek
Louis S. Miller
Howard T. Oliver
Donald E. Priewe
Alfred Rechter
John H. Rogers
Joseph J. Schachter
Felix A. Seiden
Lyman E. Wagers
George H. Wern

Personnel of the American Board of Orthodontics for 1961-1962:

J. A. Salzmann, President
654 Madison Ave.
New York, New York

B. F. Dewel, Vice-President
708 Church St.
Evanston, Illinois

Alton W. Moore, Secretary
University of Washington
School of Dentistry
Seattle, Washington

Paul V. Reid, Treasurer
1501 Medical Arts Bldg.
Philadelphia, Pennsylvania

Frank P. Bowyer
608 Medical Arts Bldg.,
Knoxville, Tennessee

Nathan G. Gaston
701 Walnut St.
Monroe, Louisiana

Richard M. Railsback
1333 Grand Ave.
Piedmont, California

President's Page

OUR Association has grown over the years to become the official representative of the specialty of orthodontics in the American Dental Association. This rapid growth and the resulting responsibilities which it produces presents a challenge to every member of the American Association of Orthodontists.

In the early days of its existence the original function of the A. A. O. (at that time called the American Society of Orthodontists) was to make available scientific sessions for the exchange and promotion of orthodontic knowledge. This function is still the Association's most important obligation to its membership, but there are now many complexities of an ethical, social, political, professional, governmental, legal, and economic nature which must be dealt with by your officers and directors. In an effort better to acquaint our membership with the nature of the problems facing us, to inform the members of measures being considered by your directors, and to meet the demands of an ever-changing social and economic pattern of our community life, this page in our JOURNAL has been made available to your President. It will serve as a vehicle for your President to keep you informed of Association activities of immediate interest to you.

As in the past, your officers and directors are engaged in an active program to guide the growth of the American Association of Orthodontists. They give generously of their time and energy to this effort. In the "News and Notes" section of this issue of the JOURNAL you will find a complete list of officers, directors, and committeemen. This list is being made available to you in order that you may correspond with any of the committees regarding questions or suggestions that you may have concerning their particular activities. These committees study and recommend action to the Board of Directors. The directors consider and act in your behalf. It is your privilege—and, I would like to add, your duty—to assist your elected and appointed representatives by informing them of your opinions.

Of greatest importance to the continued existence of orthodontics as a self-governing specialty of a respected profession is the matter of our individual dealings with our patients. Since the first days of our existence we have been provided with a written guide to help us in our relationships with our patients. We term this code our "Principles of Ethics." Close adherence to these "Principles" by every member of the healing professions, including every member of the American Association of Orthodontists, will result in the most effective

offensive against the steady onslaught of the forces advocating socialized dentistry and medicine.

This year, through our Public Relations Committee, we are conducting an intensive study of the image which the orthodontist creates in the public mind. A determination of the methods best suited to improve that image will be attempted, but the simple fact remains that the major source of that image is the orthodontist himself. Every member of the A. A. O. is our public relations agent; your actions and mine determine whether or not the public views orthodontics favorably. It is true that we do have others than our own members practicing orthodontics and contributing to the over-all public opinion of orthodontics and orthodontists.

Many general practitioners, believing that orthodontics deals in reality with simple local anomalies which respond readily to simple mechanical devices, engage in efforts to correct complex dentofacial abnormalities. This interest has become so great among these dentists that they are at present engaged in organizing numerous new societies for the study of tooth-moving techniques. These new societies encourage the orthodontically untrained and inadequately trained dentist to undertake treatment of dentofacial anomalies. While these practitioners may realize the pressing need for dental growth guidance, they are not always cognizant of the many unknowns in the glosso-oro-pharyngio-dental complex. These practitioners may actually interfere with and intensify the dental growth problems in their child patients.

Why has this situation arisen? The orthodontic specialty, by arduous study and effort, has produced results in the field of orthodontic therapy which have stimulated an increasing public demand. We must make the effort to acquaint dentists and dental students of the complexities and dangers of interference with the growing denture. It will then be their obligation to consider their acts in the light of the "Principles of Ethics."

Dallas R. McCauley, President,
American Association of Orthodontists.

DEPARTMENT OF ABSTRACTS AND REVIEWS

Edited by DR. J. A. SALZMANN, *New York City*

All communications concerning further information about abstracted material and the acceptance of articles or books for consideration in this department should be addressed to Dr. J. A. Salzmann, 654 Madison Avenue, New York City.

Abstracts of papers presented before the Research Section of the American Association of Orthodontists, Washington, D. C., April 26, 1960

A Quantitative Study of the Alveolar Bone Response to Molar Extrusion Induced by Removal of Antagonists in the Rat

By Joseph S. Azar, University of Pittsburgh School of Dentistry, Pittsburgh, Pennsylvania.

This study was undertaken to record quantitative evidence on alveolar bone response to extrusion in rats. Ten littermate pairs of Long-Evans rats were employed for experiment at each of four ages—7, 15, 23, and 31 weeks. It was believed that this particular spanning at eight-week intervals would reveal the alveolar response at varied stages of growth.

The upper right molars were removed to encourage the extrusion of the lower molars on the same side. The lower right molars in littermates of the same sex and of nearly equal weight served as controls.

Alveolar bone growth was revealed by indirect vital staining with powdered madder root in the diet. In the 31-week-old animals alizarin red S in a 4 per cent solution, injected intraperitoneally in doses of 100 mg. per kilogram of body weight was used initially, followed by madder feeding for the two weeks prior to the date of experiment. Alizarin injections were found necessary to ensure adequate background staining in this oldest group.

Ground bone sections mounted on slides were analyzed with a microscope calibrated to measure in multiples of 8.3, 3.7, and 2.3 microns.

Measurements were recorded of the unstained bone apposition at the proximal alveolar crests, interradicular crests, and fundic areas.

A statistical analysis of the data collected revealed that alveolar bone growth due to experimental extrusion occurred at a highly significant level of confidence for every age group and in every area that was examined. Comparison of the differences in the amount of bone produced in the three areas—interseptal, interradicular, and fundic—of the same age groups showed that there were no significant differences when the mean differences of the compared areas were subjected to the "t" test.

This study has revealed that age, with its associated stage of dental growth and development, is the important factor determining the response of alveolar bone to experimental extrusion in the rat and that the position at which the apposition of bone occurs is not an important variable.

1008 Garden Pl.
Glenshaw, Pa.

Functional Variations of the Temporomandibular Joint in Class I and Class II (Angle) Malocclusions

By John Catlett Rumble, D.D.S., M.S., University of Tennessee, College of Dentistry, Memphis, Tennessee.

The purpose of this study was to compare the range of morphologic variation and functional relationship of the condyle to fossa, eminence, and associated structures in Class I and Class II (Angle) malocclusions in non-orthodontic-treated children.

This study utilized the Sandusky apparatus and technique of predetermining condylar inclinations in the horizontal and vertical planes. Forty-five children, with an average age of 11 years 1 month, were examined. Adjusting the Sandusky apparatus to the predetermined condylar inclinations, four exposures were made of each joint (left and right) in the functional positions of rest, occlusion, incision, and wide open without strain.

Porion, orbitale, and maxillary molars were traced from the film taken with the mandible in rest position and then superimposed over the same landmarks in the exposures made while the teeth were in occlusion, incision position, and wide open. In each instance the mandible was traced in these various functional positions. From these tracings, angular and linear measurements were obtained of movements of the mandibular condyle from resting position to full closure, anteroposterior relation of mandibular condyle to eminentia articulare, superior-inferior relation of mandibular condyle to glenoid fossa, relation of mandibular condyle to external auditory meatus, angle of articular eminence or "condyle path," and range of variation of condyle eminence relationship in incision position and wide-open without strain.

Use of the Sandusky technique for taking roentgenograms of the temporomandibular joints of children with Class I and Class II, Division 1 malocclusions revealed a wide range of functional and anatomic variations. There was a definite tendency toward a wider range of variation in the Class II, Division 1 group than in the Class I malocclusion group, although statistically there was not a significant difference at the 95 per cent confidence level when the "t" test was used.

Of the ninety joints studied, eighty had condyles that translated in an upward and posterior direction less than 2.0 mm. For practical purposes, this movement is of a rotational type.

A significant difference was found in the vertical and horizontal condylar inclinations in the Class I and Class II, Division 1 malocclusion groups.

STERICK BLDG.
MEMPHIS, TENN.

A Radiographic Study of the Temporomandibular Joints in a Normal Occlusion Group

By Jack Armond Hill, D.D.S., M.S., University of Tennessee, College of Dentistry, Memphis, Tennessee.

Twenty young men with normal occlusion were studied by the Sandusky technique of radiographically predetermining the horizontal and vertical condylar inclinations before taking radiographs of the temporomandibular articulation.

Four exposures were made of each joint (left and right) in the following positions: rest, occlusion, incision, and wide open without strain. The films were processed, and certain anatomic points were chosen. In addition, certain lines and planes were constructed to permit the analysis of mandibular movements and relationships.

The wide range of horizontal and vertical condylar inclinations of the forty condyles which were studied radiographically emphasized the importance of predetermining the horizontal and vertical condylar inclinations of the mandible.

Movement of the condyle from rest position to full closure was rotational in over one-half the cases. In every case that exhibited translatory movement, the movement was in a superior and posterior direction.

No essential difference was found in anteroposterior relationship of the condyle to eminentia articularis when the mandible moved from rest position to full closure.

There is a wide range in the superoinferior relationship of the condyle to the glenoid fossa, but the mean change in the superoinferior relationship from rest position to full closure was quite small (0.81 mm.).

The range of condylar movement in the relationship of the condyle to the height of eminentia articularis when the mandible was in a position of incision and mouth opening was quite wide. In incision, the range was from 13.6 mm. to 3.5 mm. behind the eminence. In the wide-open position, the range was from 6.5 mm. behind the eminence to 6.3 mm. in front.

500 WEST 15TH ST.
AUSTIN, TEXAS

NEWS AND NOTES

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The following committees for 1961-62 were named at the fifty-seventh annual meeting of the American Association of Orthodontists in Denver, Colorado:

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Chapel Hill, North Carolina

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American Association of Orthodontists

It is not too early to start planning to attend the fifty-eighth annual session of the American Association of Orthodontists, which will be held April 29 to May 3, 1962, at the Statler Hotel in Los Angeles, California.

Central Section of A. A. O. to have new name

Kenneth E. Holland, secretary of the Central Section of the American Association of Orthodontists, has announced that his Society will continue to be known as the Central Section until the members adopt a new Constitution and ratify the change in the name of that Society. It is expected that the name will be changed to the Midwestern Society of Orthodontists subsequent to Oct. 1, 1961.

This announcement is made to clear up the confusion that exists regarding the date when the Central Section is to become the Midwestern Society of Orthodontists.

Northeastern Society of Orthodontists

The fall meeting of the Northeastern Society of Orthodontists will be held Oct. 29 to 31, 1961, at the Hotel Manger in Rochester, New York. This meeting is rather special, since it will mark the fortieth anniversary of the founding of the Northeastern Society. An appropriate banquet to celebrate this occasion has been scheduled for Monday evening, October 30, in the Grand Ballroom of the Hotel Manger.

The Executive Committee, under the capable chairmanship of Nicholas Ippolito, has prepared a very worth-while scientific program. Among those scheduled to appear as essayists, are such outstanding teachers and clinicians as Edward Martinek, Jacob Subtelny, Frank Lamons, Morris Stoner, Lawrence McKiver, David Ast, and William Biederman. In addition, the Local Arrangements Committee, under the able chairmanship of Barnett Frank, has assembled a splendid grouop of table clinicians who also will cover a wide range of timely subjects.

This will the first time in the forty-year history of the Northeastern Society that it will convene in the beautiful city of Rochester. The ladies are being encouraged to attend. In addition to the fortieth anniversary dinner dance, a tour of Kodak Park has been arranged for the ladies, with a luncheon provided by Eastman Kodak Company. The Northeastern Society is also providing a hospitality room, so that the ladies may be guests of the Society at a continental breakfast. While a great deal of effort has been expended in preparing an outstanding scientific program, the social aspects of the meeting have also been given considerable attention.

During one phase of the meeting, the Rochester Dental Society is planning to honor Leuman Waugh for his outstanding contributions to our specialty. This is particularly appropriate, since Dr. Waugh spent his boyhood in Rochester and it was here that he began his career in dentistry. We in the Northeastern Society of Orthodontists feel honored that Dr. Waugh has been singled out for such recognition.

Southwestern Society of Orthodontists

The next meeting of the Southwestern Society of Orthodontists will be held at the Sheraton-Dallas Hotel in Dallas, Texas, Oct. 22 to 25, 1961.

Flying Dentists Association

The first annual meeting of the Flying Dentists Association was held at the Menger Hotel in San Antonio, Texas, June 3, 1961, under the direction of President Wm. Stevenson, Jr., and Secretary John Austin.

The program included a trip to the Monterrey Dental School at Monterrey, Mexico. As a feature of the first annual meeting, the Flying Dentists attended the meeting of the Mexico Dental Association on the evening of June 8.

Dental laboratories to raise funds for dental education

The first nationwide campaign to raise funds in support of dental education will be undertaken this year by the dental laboratories, according to an announcement by Hoyt E. Cushman, president of the National Association of Dental Laboratories.

Robert J. Rothstein, chairman of the board of Rothstein Dental Laboratories, Inc., Washington, D. C., and one of the founders of the dental laboratories national association, has accepted appointment as national chairman for the campaign, Mr. Cushman stated. Mr. Rothstein will be assisted by leading dental laboratory heads who will serve as state chairmen and direct the fund-raising activities of soliciting teams in each state.

The campaign will be conducted in cooperation with the Fund for Dental Education, which is helping to develop contributions from all members of the dental family in support of dental teaching and research. As one of the important members of the dental health team, the dental laboratories recognize their companion interest in the growing future of dentistry. They see the need for substantially increasing the education and training of more dental auxiliary personnel.

"We believe that the dental laboratories are certainly justified in this decision to support the program of the Fund for Dental Education," Mr. Cushman pointed out. "It is going to result in much needed financial assistance for programs designed to increase the training of dentists and auxiliary personnel. Support of the Fund will enable all members of the dental family to produce the dental health teams needed to serve the growing demands of our increasing population."

Dr. Maynard K. Hine, president of the Fund for Dental Education, has stated that the Fund warmly endorses this action by the National Association of Dental Laboratories. "The Board of Directors of the Fund views this decision by the dental laboratories with enthusiasm," he said. "It is indeed a demonstration of true dental statesmanship."

The campaign will begin this summer among the 7,700 dental laboratories in the country and will culminate at the annual meeting of the National Association of Dental Laboratories in Chicago this fall.

New dental research center dedicated

A new building to house the laboratories of the National Institute of Dental Research was dedicated on Friday afternoon, May 26, in Bethesda, Maryland, by Secretary of Health, Education, and Welfare Abraham Ribicoff.

Dr. Francis A. Arnold, Jr., director of the Dental Institute (one of seven National Institutes of Health under the Public Health Service), presided, and Dr. Emory W. Morris, president of the W. K. Kellogg Foundation of Battle Creek, Michigan, gave the principal address.

Senator Lister Hill of Alabama, Representative John E. Fogarty of Rhode Island, and Dr. Charles H. Patton, president of the American Dental Association, took part in the program. Other participants included Surgeon General Luther L. Terry; Dr. James A. Shannon, Director of the National Institutes of Health, and Dr. John W. Knutson, Chief Dental Officer of the Public Health Service.

The $4 million building, construction on which began in 1959, was designed to house the scientific and administrative operations of the Institute, which conducts and supports research on the causes, diagnosis, treatment, and prevention of oral diseases.

General Fairbank addresses Walter Reed graduates

Brigadier General Leigh C. Fairbank (Ret.), former Director of the Dental Division Office of the Surgeon General, delivered the graduation address to class No. 25, Division of Dentistry, Walter Reed Army Institute of Research, Walter Reed Army Medical Center, in Washington, D. C., on May 5, 1961.

Notes of interest

Sidney Brandt, D.D.S., is pleased to announce the association of G. Richard Safirstein, D.M.D., in the practice of orthodontics at 10 Park Pl., Morristown, New Jersey.

C. Roy Brooks, D.D.S., takes pleasure in announcing the initiation of H. Peter Witzky, D.D.S., M.S., in the practice of orthodontics at 1800 Mack Ave., Grosse Pointe Farms, Michigan.

Irwin Steuer, D.D.S., 654 Madison Ave., New York, New York, is still practicing orthodontics in New York City. Unfortunately, some confusion regarding his whereabouts has resulted from an item in last month's JOURNAL in which the new Beverly Hills, California, address of another Dr. Irwin Steuer was reported.

Forthcoming meetings of the American Association of Orthodontists:

1962—Statler Hotel, Los Angeles, California, April 28 to May 3.
1963—Hotel Fontainebleau, Miami Beach, Florida, May 5 to 9.
1964—Palmer House, Chicago, Illinois, May 10 to 14.
1965—Dallas Statler-Hilton, Dallas, Texas, April 25 to 30.

*Officers of Orthodontic Societies**

The *American Journal of* ORTHODONTICS is the official publication of the American Association of Orthodontists and its component societies. The Editorial Board of the JOURNAL is composed of a representative of each of the component societies.

American Association of Orthodontists *Next meeting April 28-May 3, 1962, Los Angeles*

President, Dallas R. McCauley, 410 South Beverly Dr., Beverly Hills, Calif.
President-Elect, J. A. Salzmann, 654 Madison Ave., New York, N. Y.
Vice-President, J. Lyndon Carman, 501 Republic Bldg., Denver, Colo.
Secretary-Treasurer, Earl E. Shepard, 225 South Meramec, Clayton, Mo.

Central Section of the American Association of Orthodontists *Next meeting Oct. 1-3, 1961, Minneapolis*

President, Henry E. Colby, 1850 Medical Arts Bldg., Minneapolis, Minn.
Secretary-Treasurer, Kenneth E. Holland, 1016 Sharp Bldg., Lincoln, Neb.
Director, G. Hewett Williams, 811 Elm St., Winnetka, Ill.

Great Lakes Society of Orthodontists

President, Paul V. Ponitz, 914 Security Bank Bldg., Battle Creek, Mich.
Secretary, Edward A. Cheney, 2900 Grand River, Lansing, Mich.
Director, Harlow L. Shehan, 601 Jackson City Bank Bldg., Jackson, Mich.

Middle Atlantic Society of Orthodontists *Next meeting Oct. 1-3, 1961, Atlantic City*

President, Paul V. Reid, 1501 Medical Arts Bldg., Philadelphia, Pa.
Secretary-Treasurer, Charles S. Jonas, Mayfair Apts., Atlantic City, N. J.
Director, Louis E. Yerkes, 825 Linden Ave., Allentown, Pa.

Northeastern Society of Orthodontists *Next meeting Oct. 29-31, 1961, Rochester, N. Y.*

President, Irving Grenadier, 888 Grand Concourse, New York, N. Y.
Secretary-Treasurer, David Mossberg, 36 Central Park S., New York, N. Y.
Director, Norman J. Hillyer, 230 Hilton Ave., Hempstead, L. I., N. Y.

Pacific Coast Society of Orthodontists *Next meeting Aug. 6-10, 1961, Seattle*

President, E. Allen Bishop, 703 Cobb Bldg., Seattle, Wash.
Secretary-Treasurer, Warren A. Kitchen, 2037 Irving St., San Francisco, Calif.
Director, William S. Smith, 2530 Bissell Ave., Richmond, Calif.

Rocky Mountain Society of Orthodontists

President, Louis J. Williams, 843 South Center St., Casper, Wyo.
Secretary-Treasurer, Hubert J. Bell, Jr., 230 Mercantile Bank Bldg., Boulder, Colo.
Director, Ernest T. Klein, 707 Republic Bldg., Denver, Colo.

Southern Society of Orthodontists *Next meeting Nov. 5-8, 1961, St. Petersburg*

President, Charles E. Harrison, 362 Sixth St., S., St. Petersburg, Fla.
Secretary-Treasurer, William H. Oliver, 1915 Broadway, Nashville, Tenn.
Director, Boyd W. Tarpley, 2118 Fourteenth Ave., S., Birmingham, Ala.

Southwestern Society of Orthodontists *Next meeting Oct. 22-25, 1961, Dallas*

President, Bibb Ballard, 7713 Inwood Rd., Dallas, Texas
Secretary-Treasurer, Tom M. Matthews, 8215 Westchester Dr., Dallas, Texas
Director, Nathan Gaston, 701 Walnut St., Monroe, La.

American Board of Orthodontics *Next meeting April 23-28, 1962, Los Angeles*

President, J. A. Salzmann, 654 Madison Ave., New York, N. Y.
Vice-President, B. F. Dewel, 708 Church St., Evanston, Ill.
Secretary, Alton W. Moore, University of Washington School of Dentistry, Seattle, Wash.
Treasurer, Paul V. Reid, 1501 Medical Arts Bldg., Philadelphia, Pa.
Director, Frank P. Bowyer, 608 Medical Arts Bldg., Knoxville, Tenn.
Director, Nathan G. Gaston, 701 Walnut St., Monroe, La.
Director, Richard M. Railsback, 1333 Grand Ave., Piedmont, Calif.

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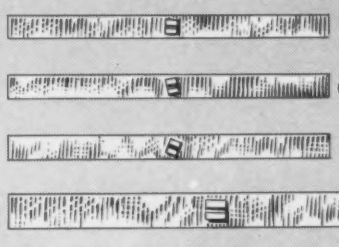

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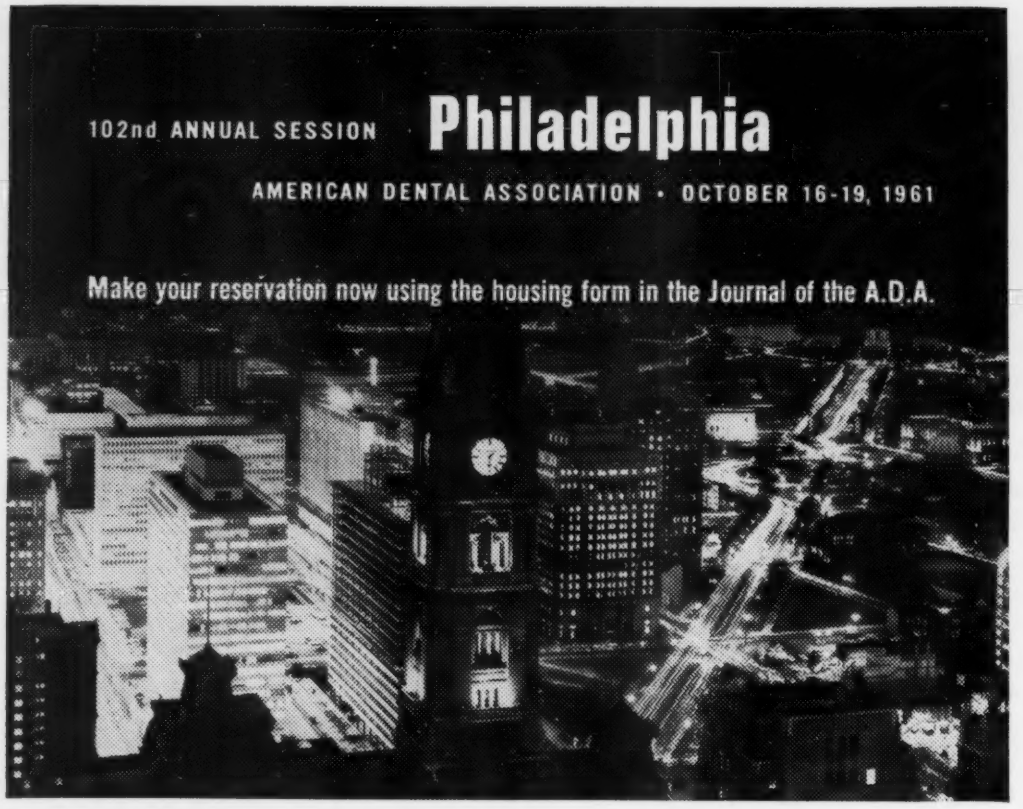
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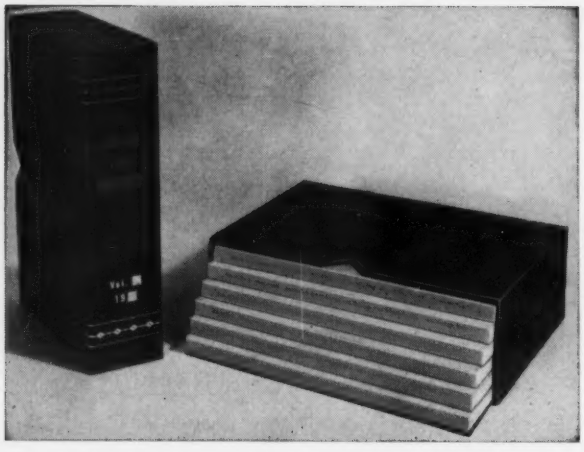

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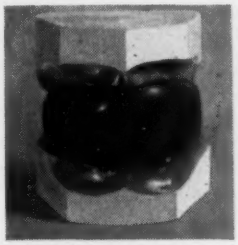

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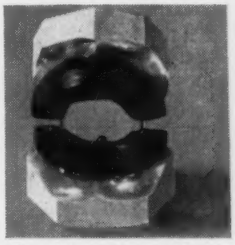

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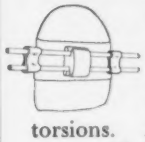

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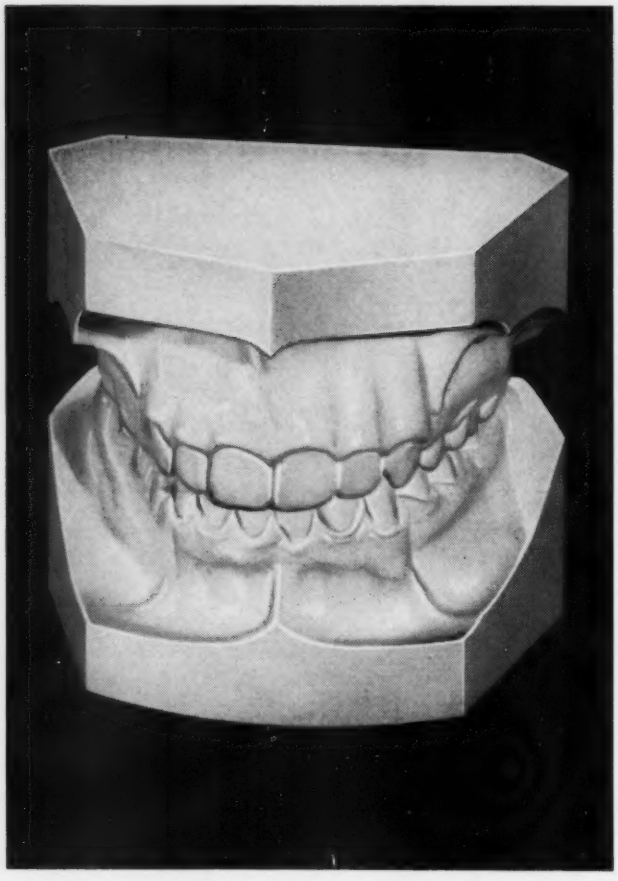

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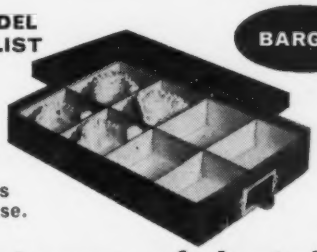

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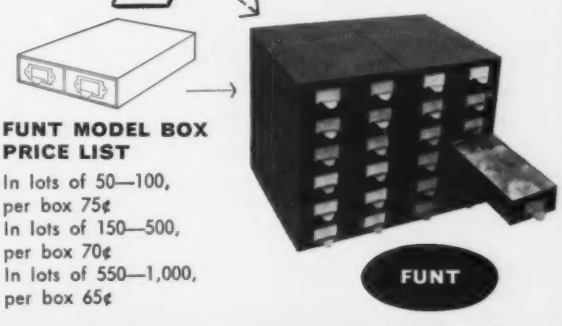

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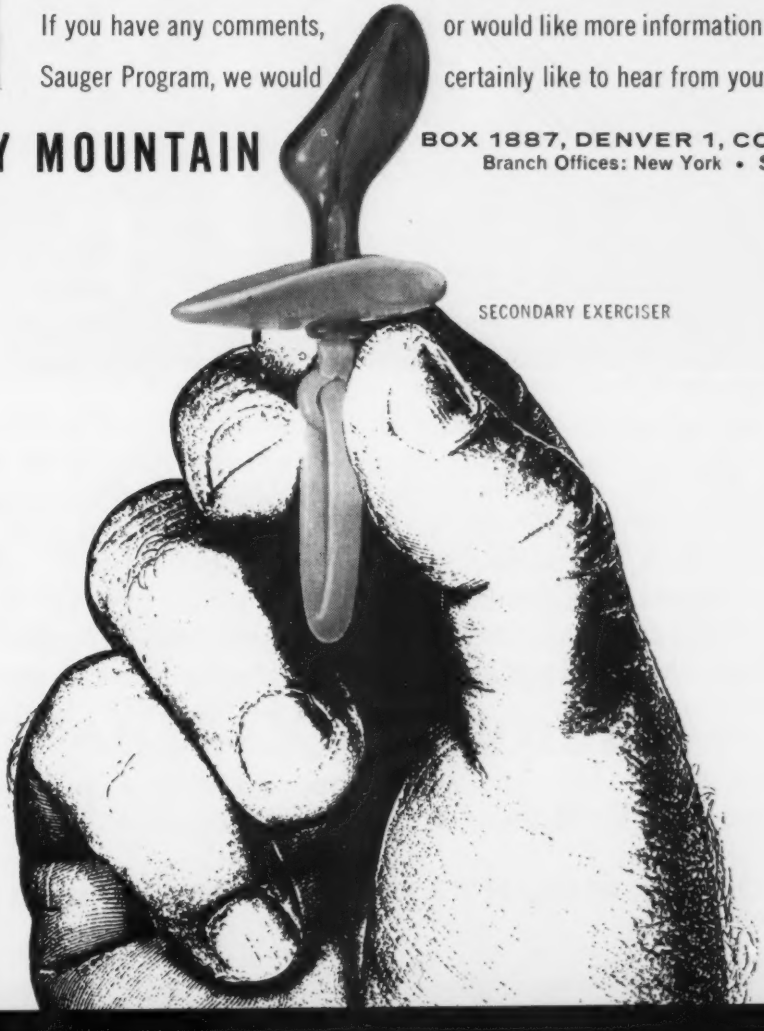

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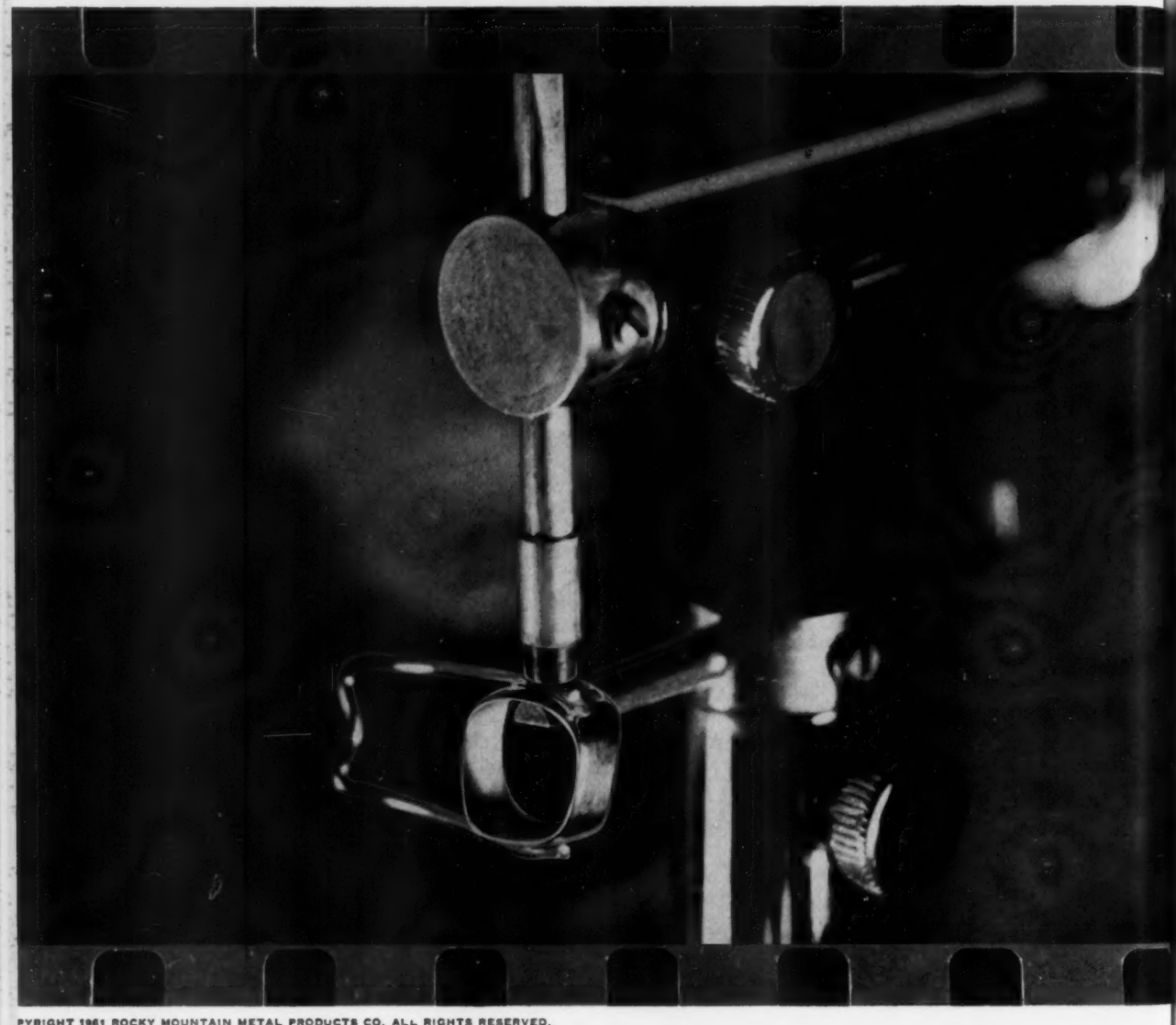

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Even if you have an old, 1934 Rocky Mountain Welder, you can electric solder with a carbon tipped, upper electrode and an anvil tipped, lower electrode. Tack weld materials for positioning . . . clean the carbon tip . . . flux liberally with R.M. Flux of liquid consistency . . . place bar solder over the materials . . . fuse and puddle the solder, as desired, by pressing and depressing the auxiliary switch-button beneath the handrest. If you would like to learn more about using this electric soldering assembly (one of 5 possible with R.M. Multi-purpose Machines), stop by the R.M. Exhibit at the next orthodontic meeting, or arrange to attend one of the Film, Demonstration, and Workshop Programs held occasionally in our New York, Denver, and San Francisco Offices.

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THE PARADOX OF ORAL CANCER

In 1961, some 13,300 cases of oral cancer will be diagnosed. Of these, only 5,000 will be cured! It is a tragic paradox that the cure rate should be so low for a cancer that is accessible and comparatively easy to detect in its early and curable stages.

Since the patient himself is often not alerted to oral cancer by pain or even by a danger signal, the dentist's responsibility is crucial. In his routine examinations of the patient's oral cavity, he has the opportunity to recognize asymptomatic lesions that may be early, curable cancer.

More and more patients are having periodic dental checkups. Their number must increase if oral cancer is to be better controlled. The American Cancer Society's public and professional educational efforts encourage earlier case findings by stressing the importance of regular health checkups and professional consultations when symptoms develop. Implementing these efforts are films, publications, exhibits, speakers. Information may be obtained at local units of the

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(Plain Cylindrical Molar Bands)

24 sizes—.007" thick—.180" wide

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EASY TO ADAPT TO SNUG FIT!

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- Platinum-colored, precious metal alloy bands . . . annealed for easy workability . . . high ductility.
- Conform equally well to upper and lower molar bends and contours.
- High-fusing . . . non-tarnishing.
- Attachments may be soldered at any point, without danger of cracking a seam.

Orthodontic Package
Contents:
½ lb. bottle powder
20 cc. dispensing bottle of liquid
2 oz. reserve bottle of liquid
$35.00

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NEW GERMICIDAL KRYPTEX®

Helps prevent decay under bands

New Germicidal Kryptex contains 0.2% mercurammonium chloride—now combines potent germicidal action with great strength and holding power . . . helps prevent decay under orthodontic bands.

The color, deep yellow, is easily distinguishable from enamel upon removal of bands . . . speeds the "clean-up" procedure. New Germicidal Kryptex may also be used for filling deciduous teeth, as well as pits and fissures in 6-year molars.

Note: Success in cementing orthodontic bands with New Germicidal Kryptex depends upon a tacky mix that resembles soft putty.

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